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FOOT KNOWLEDGE

WHAT YOU OUGHT TO KNOW ABOUT FEET

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WHAT YOU OUGHT TO KNOW ABOUT FEET

By

HERMAN W. MARSHALL, M.D.

FIRST EDITION

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FOREWORD

This collection of medical papers that deal with the topic of feet had its beginnings in a set of statements that were submitted to orthopedic surgeons and to members of the shoe trade throughout the United States for their opinions.

The original questionnaire with its wide diversity of views is appended to this printed series of articles that resulted directly from it. The questionnaire merits very careful reading and study because it is the poll of one hundred orthopedists and thirty-five non-medical voters on some of the fundamental ideas relating to feet and to shoes.

The compiler of the questionnaire became the author quite unexpectedly of the subsequent series of papers that appeared in eighteen issues of the *Boot and Shoe Recorder.* The original questionnaire was published also in the *Nation's Health,* a monthly magazine printed in Chicago devoted to community, industrial, and institutional problems. The writer's task of presenting combined viewpoints of shoe men and of orthopedists to the medical profession directly through usual channels however proved to be beset with difficulties that were unforeseen.

As an illustration of these obstacles may be cited the comment of the editor of the *Boston Medical and Surgical Journal* who said: "The criticism is that the opinions of shoe dealers are of very little, if any, value in a scientific journal; and it is the feeling of the Staff that it would be better to omit the questionnaire with the answers and simply write your own conclusions."

After the series of non-technical articles were finished an interesting task was undertaken of applying some of the ideas, which these papers contained, to practical experiments in wearing shoes, with collection of data for publication.

Permanency of form for the mass of collected ideas and facts has made a little book advisable, and it is hoped that the range of usefulness will be extended in the future in this manner.

The series of non-technical papers were abbreviated purposely to short statements that will be read by shoe fitters who are not medical men, yet the set may contain points of interest to general practitioners as well as to wearers of shoes who have had foot difficulties.

No attempt has been made to cover completely the topic of feet and their troubles; but rather a series of features have been presented that have seemed to the writer to need further description or illustration.

FOREWORD

Thanks are given here to all who have so kindly assisted the writer in his efforts, the Rebman Company of New York for numerous illustrations; many orthopedic surgeons and shoemen who co-operated in making the questionnaire a possibility; other physicians who have contributed illustrations; Lt. Col. Charles Wellington Furlong; and Mr. A. D. Anderson, editor of the Boot and Shoe Recorder, who had vision to see what interest would be aroused by the series as well as courage to present medical material to non-medical readers of a trade journal.

Herman W. Marshall, M.D.

86 Bay State Road,
Boston, Mass.

EDITOR'S NOTE

"Is this what they are wearing?"

"What is the Price?"

These are the two questions most customers ask in buying shoes. These are the two thoughts that are uppermost in their minds. Herd buying is what the first infers. If *they* are buying it then it is all right and everybody wants it. If *they* are not buying it then only a few will put comfort, efficiency, ease of mind, above pride and the wearing of what they ought to have.

"Until pain interferes with occupation of pleasure, the average person does not question the shape or construction of his shoes.

"But when peace of mind and comfort of body have departed, when social functions cannot be enjoyed, when regular occupation can no longer be pursued with decent efficiency, when pains wrack the body—then the men and women go to the orthopedic surgeon or to a shoe store, tell them their story and expect to be immediately restored to a normal healthy condition.

"It is beyond the power of any human being to reconstruct nerve cells, blood corpuscles or other elements of the human body that have been destroyed. Only God, or nature, or the Supreme Power, or whatever name by which one wishes to designate it, who originally created these elements, can recreate them.

"All that lies within the power of man to accomplish is to relieve the condition already created, to remove pressure from parts of the foot that are not intended to be oppressed and distribute the weight of the body as nearly as possible upon the parts designed to carry it.

"What does your foot do when you walk barefooted? How do the different parts of the foot function as you walk, run or dance in your bare feet?

"All parts of the normal foot should function as nearly possible in the same way when shoes are worn. The weight of the body should be borne by the same part when encased in a shoe as when going barefoot.

"It is not beyond human possibilities to build a shoe that will allow a foot so to function. As a matter of fact, such shoes are now on the market and are being sold in many shoe stores. In most cases they are the development of merchants or orthopedic surgeons, or a combination of the two who are more interested in supplying to the public what they should have to increase their efficiency and making a money profit thereby, than in merely catering to the fickleness of style for the moment and taking a chance on making a profit regardless of the efficiency or comfort of the customer.

EDITOR'S NOTE

"In some way or another, people seem to think that a shoe to be perfectly adapted to the human foot must be grotesque, ugly, and ungainly, just as they seem to think that a medicine to have curative properties must be nasty and unpalatable.

"It is entirely possible to make shoes that are good looking and at the same time that will allow the feet to function properly. It is not possible, however, to make shoes with extremely high heels and extremely pointed toes on rocker bottom lasts with the measurement from heel to ball all out of proportion to the corresponding measurements of the human foot, and still have shoes that will allow the feet to function properly, and also regardless of how much hardware is built into their construction."

Thus does one of Chicago's most prominent and most prosperous specialty shoe merchants express himself on the shoe situation as applied to the shape and the styles of present-day footwear.

Within comparatively recent years a few factories have had lasts made that more nearly conform on the bottom to the shape of the natural human foot. There seems to be a rapid tendency in that direction, and it is entirely possible that the shoe industry will soon recognize the fact that one of its greatest missions is to make the people more efficient, more happy and more capable of producing more wealth, and that thereby the shoe industry will reap the reward of the beneficient work.

Editor,

Boot and Shoe Recorder

TABLE OF CONTENTS

PART I

A SERIES OF SHORT NON-TECHNICAL DESCRIPTIONS OF FUNDAMENTAL MEDICAL IDEAS ABOUT SHOES AND FEET

PAGE
CHAP. I—Introduction 1
CHAP. II—A few features of foot development 3
CHAP. III—Certain details of bone growth 8
CHAP. IV—Bunions 11
CHAP. V—Enlargements about great toes 16
CHAP. VI—Policeman's heel 20
CHAP. VII—Foot tendons and tendon troubles 26
CHAP. VIII—Sesamoid bones 32
CHAP. IX—Hammer toes 37
CHAP. X—Circulation and circulatory troubles of feet 42
CHAP. XI—Nerves of the feet 49
CHAP. XII—Muscles that move the feet—first installment—General Arrangements 54
CHAP. XIII—Muscles that move the feet—second installment—Minute structure of muscles 61
CHAP. XIV—Muscles that move the feet—third installment—Muscle physiology 66
CHAP. XV—Ligaments, Joints, Bones 72
CHAP. XVI—Flexible shoes, stiff shoes, arch supports 79
CHAP. XVII—Front parts of feet and of shoes—Aboriginal feet 85
CHAP. XVIII—Foot Proportions and Shoe proportions 90
CHAP. XIX—Influence of foot posture on symptoms in Backs, Hips and Knees 94

PART II

PERSONAL EXPERIMENTS IN WEARING ORTHOPEDIC SHOES WITH INTERPRETATIONS OF RESULTS, AND WITH OTHER COMMENTS

PAGE
CHAP. XX—Personal experiments in wearing orthopedic shoes with interpretations of results, and with other comments 99
CHAP. XXI—Personal experiments in shoe wearing 106
CHAP. XXII—X-ray appearances of the foot within different shoes 110
CHAP. XXIII—Various conclusions and additional comments 116

PART III

A COMPILATION OF CURRENT NOTIONS OF FEET

PAGE
CHAP. XXIV—Ideas formulated by orthopedic and retail shoe merchants 120
CHAP. XXV—Discussion of questionnaire 148

FOOT KNOWLEDGE

PART I

A Series of Short Non-Technical Descriptions of Fundamental Medical Ideas About Shoes and Feet

CHAPTER I

INTRODUCTION

Predictions can be made in advance that a few shoe men at least will say that they are not interested in such medical stuff. Some physicians undoubtedly will remark that a little medical knowledge is dangerous, and that shoe clerks should not be encouraged to learn facts of medical character that may lead them to attempt unjustifiable things not belonging properly to their sphere of activity. The writer himself was opposed decidedly at first to the idea of a series of articles until careful consideration compelled a change of viewpoint.

A little medical knowledge may be dangerous for shoe clerks, but entire lack of medical knowledge is even more dangerous; because shoe clerks must fit feet with shoes, and feet will continue to be regulated in their functions by definite scientific physiological principles. If shoe fitters do not know these underlying principles they cannot fit shoes most skillfully in uniform manner. Knowledge of foot deformities and of bones of feet are insufficient.

Let it be supposed for sake of presenting worst possibilities that many shoe fitters imagine that they are real doctors because of increased understandings. There will be others who will apply their increased knowledge more skillfully in the fitting of customers without attempts at becoming pseudo-physicians. They will appreciate limitations of shoes better, as well as favorable possibilities of footwear; and they will advise physicians' opinions being received more frequently, quickly and discriminatingly, than those with no appreciation of medical principles.

There are bound to be some risks incurred in whatever course is adopted. Encouragement, therefore, should be extended to progressive careful members of the shoe trade and of the medical profession in their efforts toward closer co-operation, rather than attempting the minimization of medical abuses by discouragement of all medical knowledge among laymen.

Many shoe retailers in the past may have been interested mainly in selling shoes with little thought of medical problems, or of subsequent tendencies of footwear on their customers. Today is another day and every retailer is looking ahead intently. New tendencies are crystallizing in these unsettled times, and hints of future lines of progress are in evidence already. Numerous progressive shoe men are showing lively interest in undeveloped medical possibilities of their business, more skillful applications of medical ideas by themselves in the fitting of shoes and greater co-operation with suitable members of the medical profession.

There is increasing familiarity with orthopedic ideas concerning footwear,—erroneous notions as well as correct ideas,—in nearly all circles of society. The group of progressive shoe merchants seems likely to constitute a so-called "bloc" that will swing the present delicate balance of opinion toward new profitable lines of future growth.

Perhaps it is fair to say that some of the most advanced members of the shoe trade today wish to know all that can be learned of practical medical matters, and yet who desire to restrict themselves more perfectly to their business of fitting and selling shoes for the more complete satisfaction of their customers.

Also it seems fair to say that physicians who are advanced in their profession realize their own limitations, and desire to remain more closely within their own spheres, yet are eager to learn about topics poorly understood by them with which shoe merchants are familiar.

Medical men have to learn that there are as many important differences among members of the shoe trade as there are differences among regular medical practitioners and various special medical cults. Shoe men have to learn to distinguish between orthopedists, osteopaths, chiropodists, general practitioners, physiotherapists, and others.

Orthopedists from many cities of the United States answered the writer's questionnaire on shoes and feet; and well-known shoe merchants, as well as the Editor of the "Recorder" have expressed the opinion that a series of articles should follow naturally by the writer after so many persons have contributed their opinions. For these reasons he will try modestly to execute his part in the program

CHAPTER II

A FEW FEATURES OF FOOT DEVELOPMENT

Different shapes of feet are familiar, also X-ray appearances of feet; nevertheless, much still needs to be generally understood by shoe men about bony development.

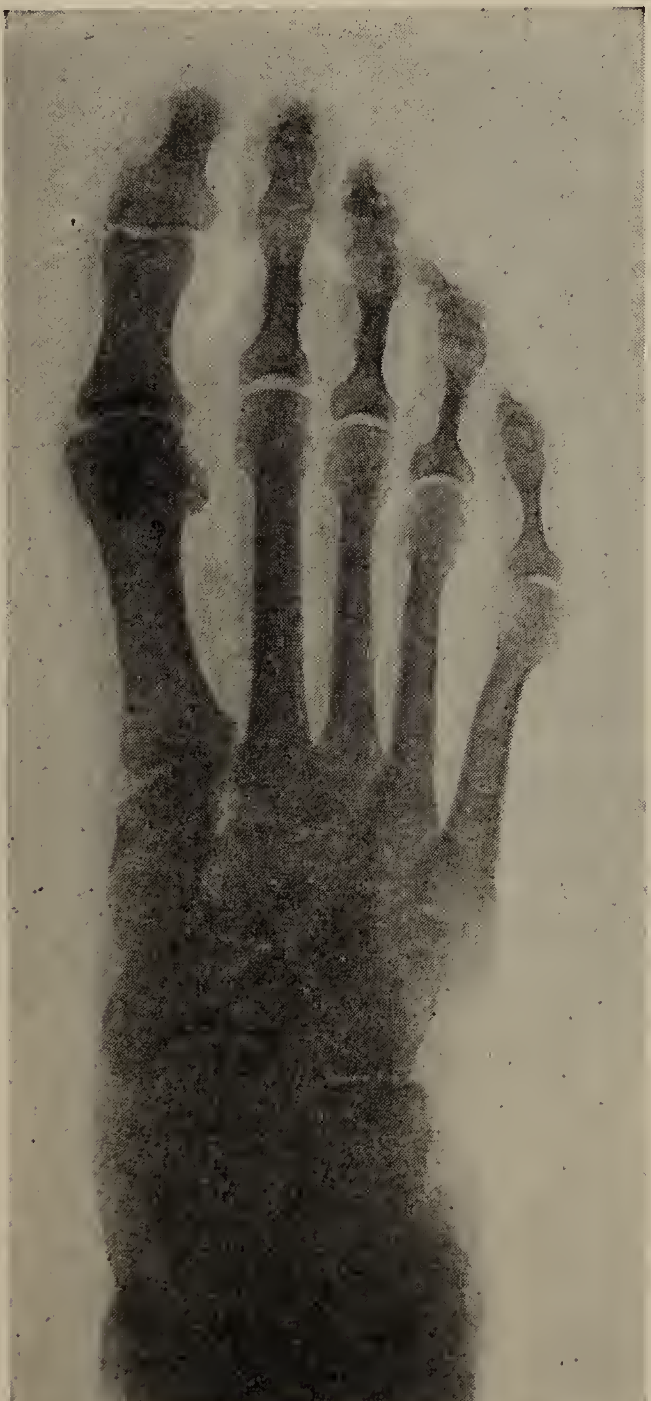

Figure 1—X-ray of an average adult foot

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An average adult foot is shown as it appears in X-ray in Fig. 1. Bones have attained their complete size and final form. It is hardly necessary to call attention to the narrow clear spaces between bones, and to explain that they represent joints lined with resistant smooth cartilage. Cartilage does not show in X-rays, owing to its peculiar structure. It is tough and well suited to stand wear and tear of continual sliding of hard surfaces over each other. Cartilage is attached firmly to adjoining bone on one side, while its opposite free surface is in contact with cartilage covering the bone on the opposed joint surface.

Fig. 2 shows a less common appearance in the feet of a five-year old child. Notice that there are not as many bones showing clearly as in the adult, also that spaces between bones are very much greater. Feet in infancy are soft and cartilaginous. True hard bone appears first as small spots in some of the soft cartilaginous bones before birth. And these spots, or ossification centers as they are called technically, grow gradually in size and numbers until all bones contain them in some stage of growth. There is more than one ossification center in many completely finished bones, for when growth is approaching com-

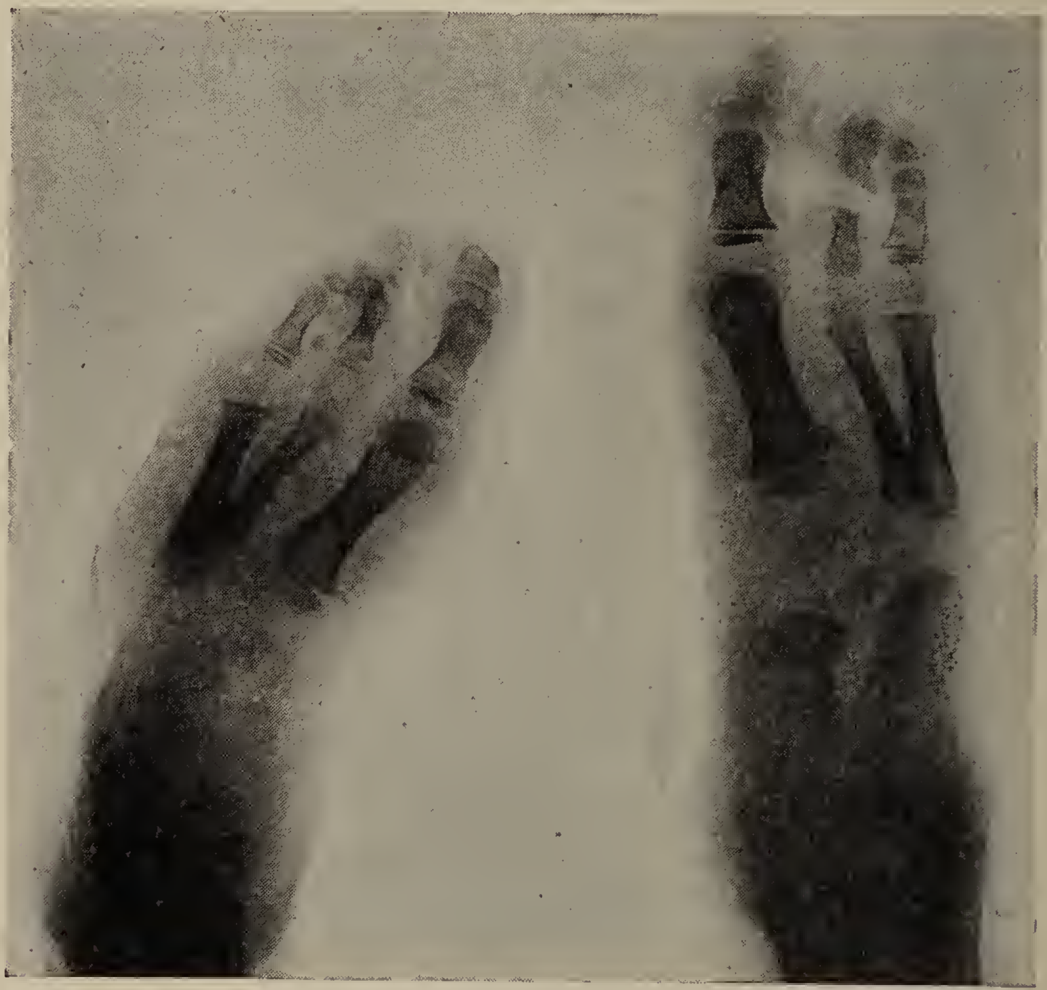


Figure 2—X-ray of feet of five-year-old child, showing unusual variations in bones

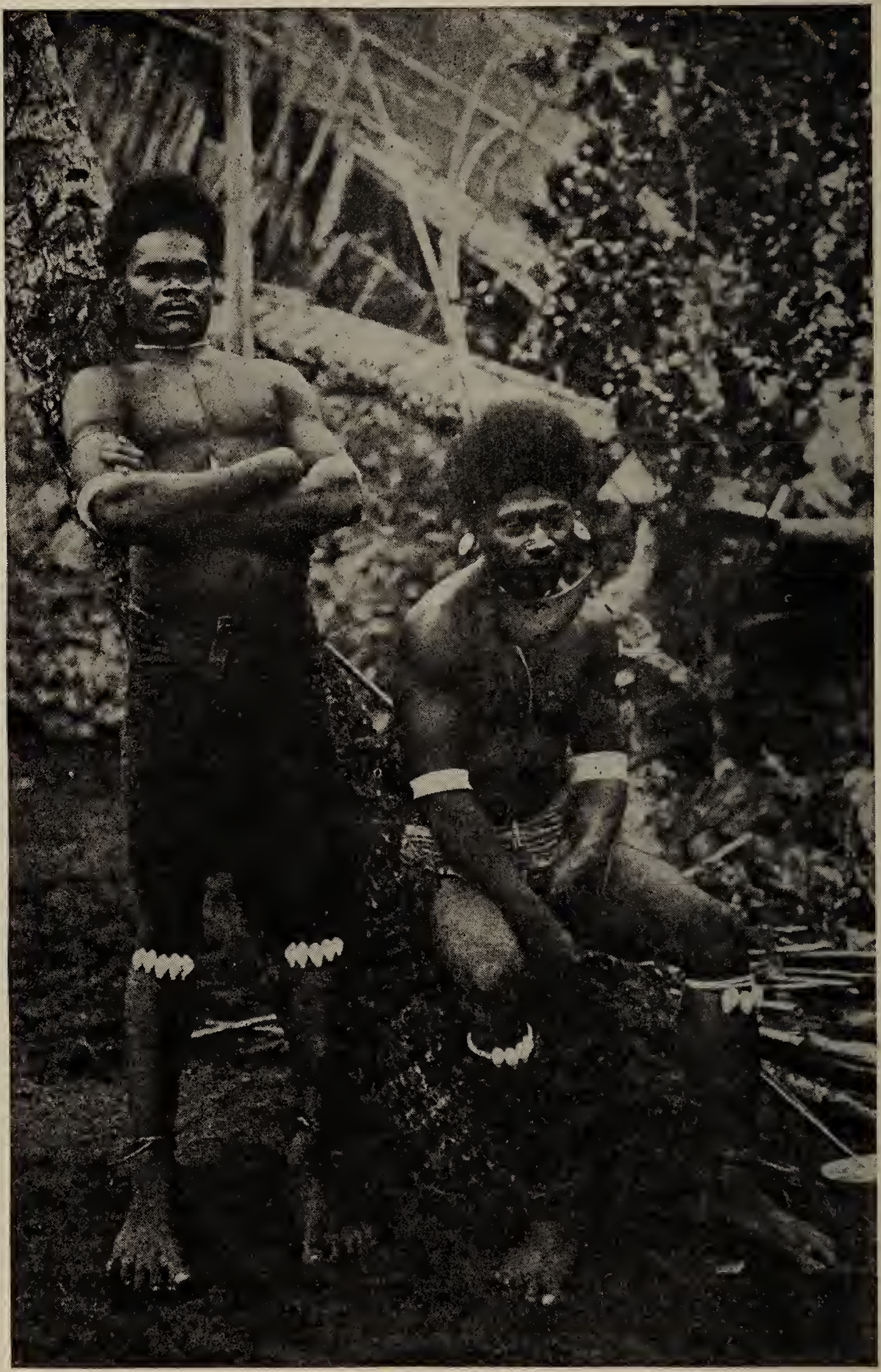
pletion, some centers fuse with adjoining ones. An illustration is furnished in Fig. 2, where it may be seen that usual sections of great toes have an additional bony disc at the base of each joint. These latter will become united completely with the longer sections later. Such arrangement is needed to permit the bones to grow in length easily as the individual grows.

Normal feet that have never been restricted by shoes may develop into the condition represented in Fig. 3. These South Sea Islanders presumably have been guiltless of wearing foot coverings. Notice how broad and well developed have become front parts of their feet. The toes are evidently very serviceable. Arches of the feet are low. Modern civilized customs tend to protect the feet too much very often, and feet are squeezed in all directions into smaller space for the sake of neat appearance. Persons may slowly cripple themselves without even knowing that they are doing so, because the crippling process is very gradual and without pain. Practically everyone unconsciously is undergoing such changes. Comparison of one's feet with the feet of these uncivilized individuals may show how far the crippling tendency has advanced.

The process of ossification, or bony hardening, is completed by the time that an individual has attained the age of eighteen to twenty years. During early life obviously feet should be allowed to expand freely and to grow as their nature intended them, yet how frequently is this need disregarded.

Fig. 2 was chosen because it shows another very important fact about bones. They may vary in number as well as size and proportions of individual bones. This youngster was born with three toes only on each foot for some obscure reason. He is a lively, normal individual in all other respects. Sometimes there are more than five toes, and rarely there may be as few as a single toe. Obscure processes that produce these results may be likened to defects in flower buds that produce imperfect blossoms of variable degrees. Theories will not be discussed, but the fact should be dwelt on that there are many natural bony variations in numbers, sizes and shapes of foot bones, and that dividing lines between normal and abnormal appearances are not always clearly defined when variations are slight.

Bones of the right and of the left foot shown in Fig. 2 can be seen to differ a little. The left foot at this stage tended to toe in badly, and the heel would not reach the floor readily on account of a short heel cord. There was a correcting adhesive strap attached to the



Photograph by J. W. Beattie Copyright National Geographic Magazine
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Figure 3—Soloman Islanders from the South Seas, showing foot types developed in healthy barefooted individuals

foot that exerted a constant slight pull in a direction favorable for straightening the foot. The adhesive strip extended upward on the outer side of the leg. Thus were modified pressures and tensions under which bones developed, and they responded by growing more perfectly in desired directions. In this instance it became necessary also to cut and to lengthen the heel cord a little, in order to release the foot sufficiently, and to assist it in assuming the usual posture held by normal feet.

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CHAPTER III

CERTAIN DETAILS OF BONE GROWTH

BEST MECHANICAL PRINCIPLES ARE UTILIZED IN BONE CONSTRUCTION, AND NATURE PRACTICES CERTAIN ECONOMIES THAT DESERVE NOTICE. BONES POSSESS CONSIDERABLE ADAPTABILITY DESPITE THEIR HARD RIGID CHARACTER. THEY ATTEMPT TO FIT THEMSELVES IN EARLY LIFE ESPECIALLY TO ALL CONDITIONS IMPOSED ON THEM; AND THEY DO AS WELL AS THEIR ADAPTIVE POWERS PERMIT EVEN WHEN FORCED TO CONFORM TO DEFORMING, POORLY SHAPED, POORLY FITTED SHOES.

Fine lines, or striations, are seen filling completely the outlines of bones of the feet as shown in the two X-rays that serve as illustrations; but let attention be directed wholly to the large bone that forms the heel. If the actual bone could be examined there would be found a compact hard outer shell with an interior arrangement of thin rigid intersecting bony plates suggestive of the structure of a sponge. This arrangement provides desirable bone size while combining essential elements of lightness and rigidity.

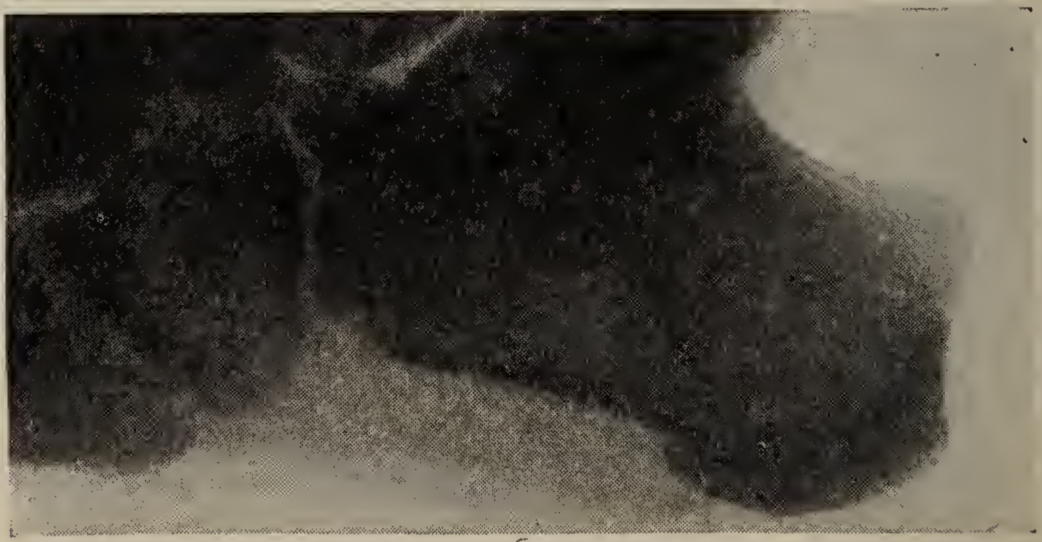

Figure 4—X-ray of heel bone of an active normal person

Fine lines in the X-rays have definite directions for definite reasons. They reinforce the outer bony shell, and are located according to accurate mechanical principles for purposes of withstanding mechanical pressures, stresses, and strains that the heel is subjected to normally. Some lines are heavier than others, and they are grouped so that strongest ones, or trabeculae as they are sometimes called, will resist strongest strains.

In passing, it should be stated that similar spongy bone occurs in many regions of the body.

These bony lines or trabeculae may change from time to time. They can become thicker and stronger if needed. In old age, or when bones are not used, they may become thin and weaker. Figure 4 shows the heel of an active person and the bony lines are numerous and fine. In figure 5 the lines are coarser and less densely packed. The pattern is not quite as fine, and this person had been suffering from a broken leg for a long time so that bones had not been used much.

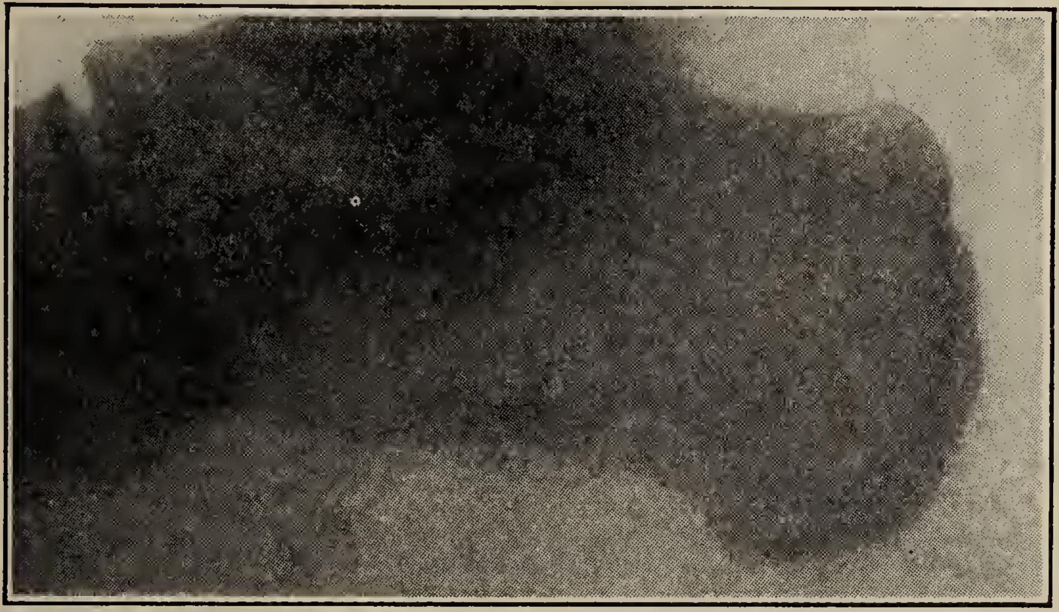

Figure 5—X-ray of heel bone of a person who had not used his foot for a considerable period

Even rigid bones are constantly changing. There is a constant deposition of lime in them, and also a constant absorption of lime from them. What might seem at first to be a useless, endless, turning over process is in reality a valuable one.

The fixed form of a bone may be compared to the fixed form of a whirlpool or an eddy in a rapidly flowing stream of water. Water flows continually in and out of the eddy at a rapid rate, yet the latter retains its shape, moving back and forth a little from time to time in response to variations in the inflow and outflow.

In bones, lime is brought by the blood stream and deposited where it is needed most, while lime that is superfluous is removed. Nature is economical as well as efficient, and in this way patterns of trabeculae may slowly change if strains on bones vary from time to time.

Although not relating to foot development, as an example of natural economy the fact may be mentioned that small spaces within rigid spongy bone serve an independent purpose. While their walls are built on best mechanical principles to withstand strains, in the small spaces are manufactured incredible numbers of blood corpuscles which give red color to circulating blood and serve a very useful special purpose as they float along in the blood stream. Blood corpuscles are produced in the red marrow of all bones.

Deformities produced by too tight, short, or poorly shaped shoes are results mainly of defective development from compression in spongy ends of toe bones. Hard compact bone will not yield as does the fine bony network found at bases of toes. Therefore shoe fitters should give the latter a chance to grow normally instead of having to adapt themselves to deforming outside pressures exerted by bad shoes.

CHAPTER IV

BUNIONS

BUNIONS ARE SUCH COMMON CAUSES OF FOOT TROUBLE THAT METHODS OF TREATMENT HAVE BEEN INVESTIGATED EXHAUSTIVELY. DIFFERENT IDEAS HAVE BEEN ADVOCATED ENTHUSIASTICALLY, AND, AT TIMES, MERITS OF ONE TREATMENT HAVE BEEN COMPARED SO EXCLUSIVELY WITH DISADVANTAGES OF OTHERS, THAT IMPARTIAL CONSIDERATION OF ALL MAY POSSESS THE VALUE OF CLEARING AWAY SOME OF THE UNCERTAINTIES WHICH SURROUND THE TOPIC.

The first illustration, figure 6, shows a moderately well developed bunion on the right great toe. The picture was taken as the person stood on a thick plate of glass, with a mirror arranged beneath so that reflected images of the soles could be photographed conveniently in weight bearing posture.

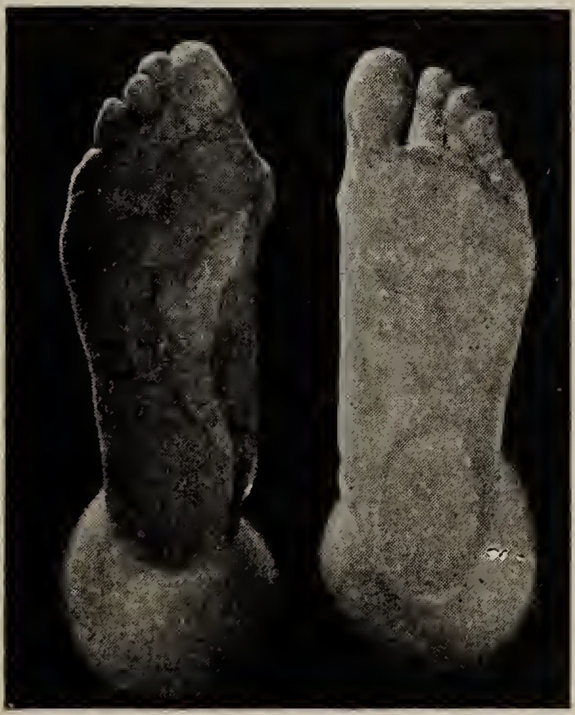

Figure 6—Photograph of soles of feet with bunion and toe deformity showing in one foot

Outlines of weight bearing areas may be observed, also spots of heaviest pressure from variations of shadings in the picture. The hazy whitish area under the right instep was caused by condensation of moisture on the cool glass plate from the reddened hot irritated foot.

Notice that the line of the inner side of the left foot is comparatively straight, whereas this straightness on the right foot has been destroyed by the deflected toe and the bunion at its base.

What should be done for this bunion?

An orthopedic surgeon might advise an operation, and support his opinion with good results that he has obtained in similar cases. A shoe fitter might recommend change of footwear, and back up his ideas with customers whom he has relieved of painful symptoms without operations. Both opinions must be accepted. Bunion shields might be proposed; or a change of stockings advocated on the ground that feet may be tied up improperly within good shoes by stockings that tend to deform them.

Bunions are results of too much and too long continued local mechanical irritation. They are accumulations of fluid in small sacs beneath the skin, as blisters on the surface of the skin are local accumulations of fluid that protect its underlying layers from irritation. A more deeply situated bursa, as a bunion sac is called, is an equalizer of pressures, a water cushion. Underlying bony prominences are protected from uneven outside pressures, while overlying soft tissues are shielded against underlying bony irregularities by equalization of pressures in all directions within the sac.

The great toe joint is the common location for bunions as is well known. Painful swellings occur also at bases of little toes that are caused by similar mechanical pressures.

Variable degrees of bony prominence are important factors in bunion production. Persons who are born with prominent toe bones are more susceptible than those with less prominent bones, other factors being equal. Bony enlargements develop slowly during life from chronic diseases in some persons. Pointed toed shoes which are fitted too short and too tightly are most important causes of prominent great toe joints.

Bunion shields relieve pressures over bunions, but they transfer shoe pressure forward to adjacent regions where shields bear against sides of toes. They tend to increase rather than to diminish bony prominences, acting in this manner as pointed shoes do. Shields cannot be recommended for prolonged use, because of their tendencies to increase deformities; but they will relieve distressing symptoms temporarily.

Considerable relief is afforded in those instances in which roomy shoes, laced snugly at the waist, are substituted for badly shaped and badly fitted tight shoes. Neither shoes nor shields however will restore former shapes of many feet. Prominent joints in which painful symptoms have subsided remain a menace until bones are straightened. The future menace of prominent joints should not be over-estimated on the other hand, when so many persons possess great toes that exhibit noticeable deflections without any history of foot trouble.

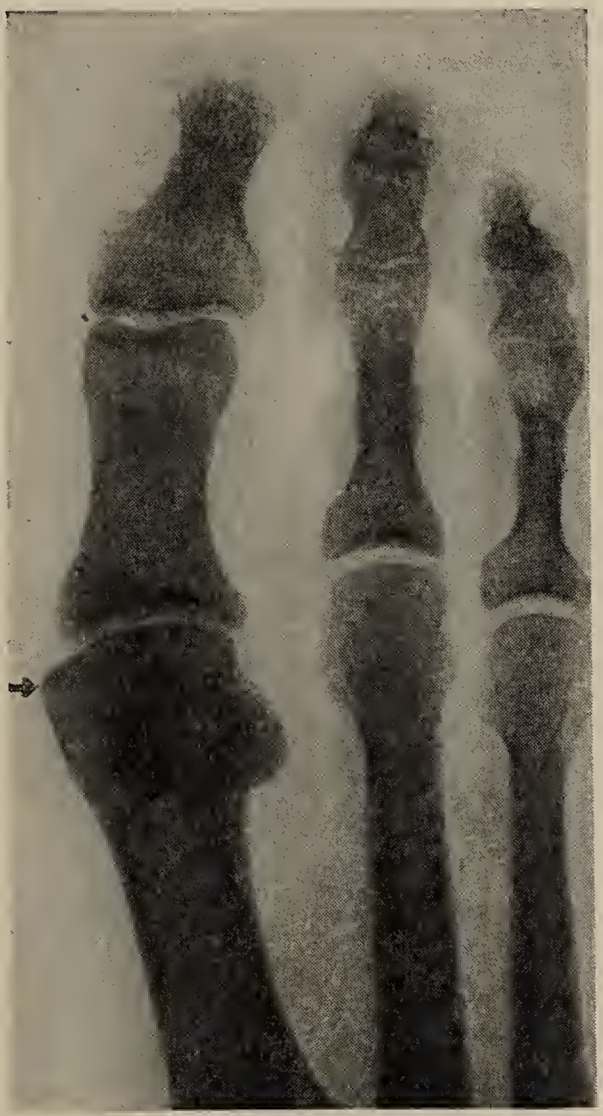

Figure 7—X-ray of bones of the great toe of a young woman. Compare with Figure 8
Courtesy of Dr. A. W. George, Boston, Mass.

The risk of continuance of bony deformities in symptomless useful feet needs to be weighed carefully against disadvantages of operations as well as compared with merits of the latter.

Operations for bunions usually include corrections of bony toe deformities, and then they are called "hallux valgus" operations by orthopedists.

Figure 7 shows bones of the great toes and two adjacent toes of a

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healthy young woman whose feet are symptomless. There is considerable toe deflection. The most prominent bony point is at the head of the first metatarsal bone. See arrow.

Figure 8 shows great toe bones and bones of two adjacent toes of an older person whose feet were painful. Here there is slightly less toe deflection, and this joint has been operated on. A thin wedge of bone has been removed from the head of the metatarsal bone, and the latter is no more prominent than the base of the adjacent section of the great toe. See arrow. Bony ends in the operated joint are more widely separated than normal because this X-ray was taken soon after operation before complete subsidence to a normal state had occurred. The toe that has been operated on is slightly shorter than it was previously; but it was deflected considerably more then than it is now.

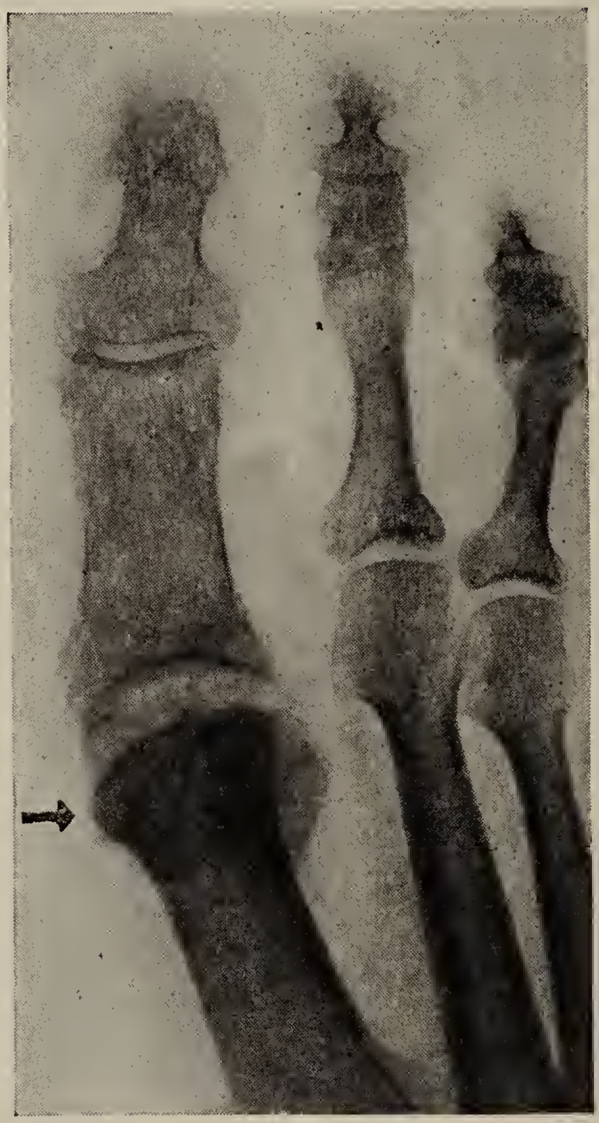

Figure 8—X-ray of bones of the great toe of a middle aged woman after an operation at which a piece of bone was removed at the base of the toe
Courtesy of Dr. W. R. MacAusland, Boston, Mass.

Advantages of operations consist in restoring normal straight alignments of bones; in diminishing pressures at bases of the toes; and increasing functional efficiency of such toes so that tendons which move them can pull evenly in their intended directions along the bony toe axis. When deformity increases toe efficiency diminishes, and *vice versa.*

Disadvantages of operations consist in additional trouble involved; loss of time; expense; sacrificing of toe length with slight impairment of appearance of the foot; and possibility of failure in relieving deformity through its recurrence after operation.

It is the writer's personal belief that operations are done unnecessarily sometimes; and that they should be reserved for cases which have caused considerable trouble for years. Marked severity of persistent symptoms justify an operation in a moderately deformed foot more than marked deformity does in a painless serviceable foot.

An individual's social position and occupation have to be considered in advising treatment. If disability arising from very bad bunions interferes with the usual occupation then positive surgical treatment should be advised promptly. If there is good opportunity for favoring the feet then non-surgical measures ought to be given thorough trial.

It is well to remember that bunions belong to their owners, and that the latter are entitled to be told fairly the various possibilities of their situations.

CHAPTER V

ENLARGEMENTS ABOUT GREAT TOES

THESE INCLUDE BUNIONS, CHRONIC DEFORMING JOINT DISEASES CALLED ARTHRITIS DEFORMANS, GOUT, BONE TUMORS, AND ACUTE JOINT INFECTIONS. THEY ARE MENTIONED IN THIS SECTION. SESAMOID BONE TROUBLES CONTRIBUTE ANOTHER CAUSE FOR PAINFUL GREAT TOES AND ARE DISCUSSED IN A SEPARATE CHAPTER. COMPLETENESS NECESSITATES MENTION OF THE INFLAMMATORY BONE DISEASE CALLED OSTEOMYELITIS, AS WELL AS BONY FRACTURES; BUT THESE ARE OMITTED FROM PRESENT DISCUSSION.

Bunions are common types of enlargements which are produced by the bony prominences of normal bones frequently as toes are deflected by pointed shoes. These prominences are increased further by accumulations of fluid in sacs or "bursae" at bases of the toes. Figure 9 illustrates this trouble with distended sacs of fluid under the skin of each

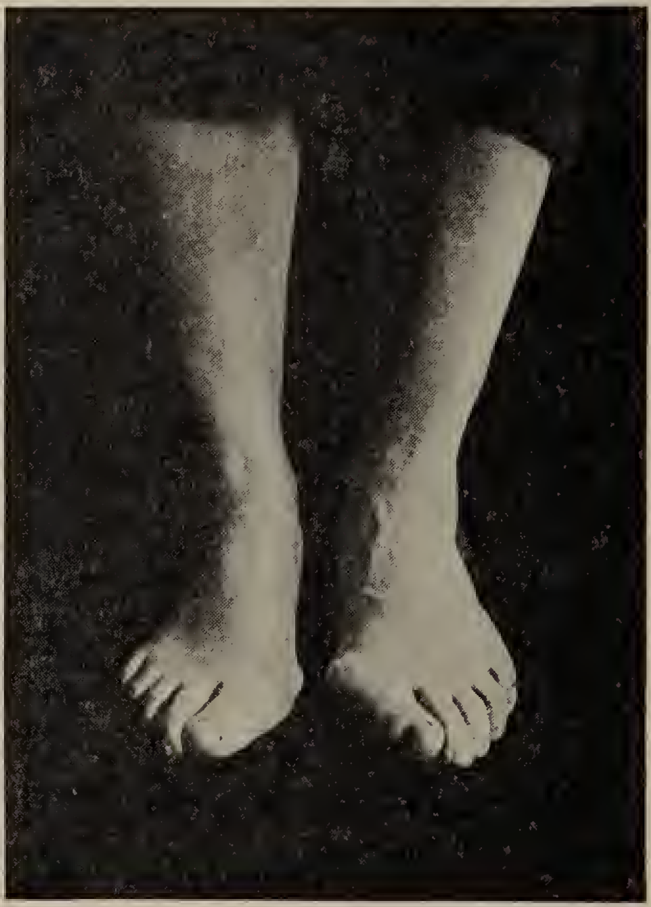

Figure 9—Typical bunions with toe deflection

great toe. Bursal sacs may become badly inflamed and infected at times, and toes in consequence may be markedly swollen.

All swellings are considered bunions by some individuals if they occur about great toes, yet there are very important differences among swellings that occur.

Figure 10 shows an X-ray of bones of a great toe of a middle-aged man. He noticed a swelling that appeared gradually on the upper side of the joint, and which began to interfere with motions of the toe in a few months. The toe became sore in consequence, and an X-ray was taken which revealed a tumor starting to grow out from the head of the first metatarsal bone like a mushroom. See arrow. This tumor has been removed since at an operation because such growths sometimes become malignant, spreading to other regions of the body. The patient has returned to his former occupation and he has very little trouble now in walking.

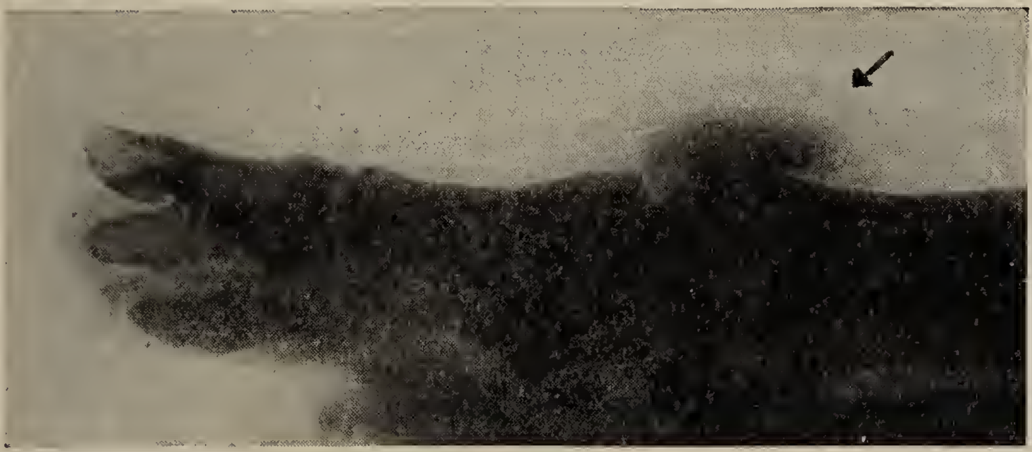

Figure 10—X-ray of bony tumor growing from upper side of great toe at its base—courtesy of Dr. L. R. Daniels, Watertown, Mass.

Gout attacks soft tissues of great toes. In gout there may be excessive amounts of chemical substances called urates in circulation, and these urates may be deposited as white chalky granules in the skin. Figure 11 is a drawing taken from an old French medical book on gout written by Garrod. This illustration shows spots of chalky urates in the skin, the swollen appearance of the toe, and a hole in the skin where one of the chalk stones had ulcerated through it.

Acute gouty attacks begin with severe pain which one of the old medical writers says "insinuates itself with the most exquisite cruelty among the numerous small bones of the foot, in the ligaments of which it is lurking." The joint rapidly swells and becomes hot, tense and shiny. Then in a short time the pains begin to abate and may cease after a week or longer, the swelling also diminishing until the next acute attack is experienced. Gout is a comparatively rare disease, however, and hot, painful swellings are more liable to be of other origin in the large majority of cases.

Arthritis deformans is an obscure trouble that runs a prolonged course with periods of increased pain and soreness alternating irregularly with intervals of quiescence. Its origin will not be discussed, but appearances of the feet and one hand are illustrated in Figure 12. There is more than one type of chronic deforming diseases of joints, but differences between different types cannot be discussed briefly, and therefore will be dismissed in the present connection.

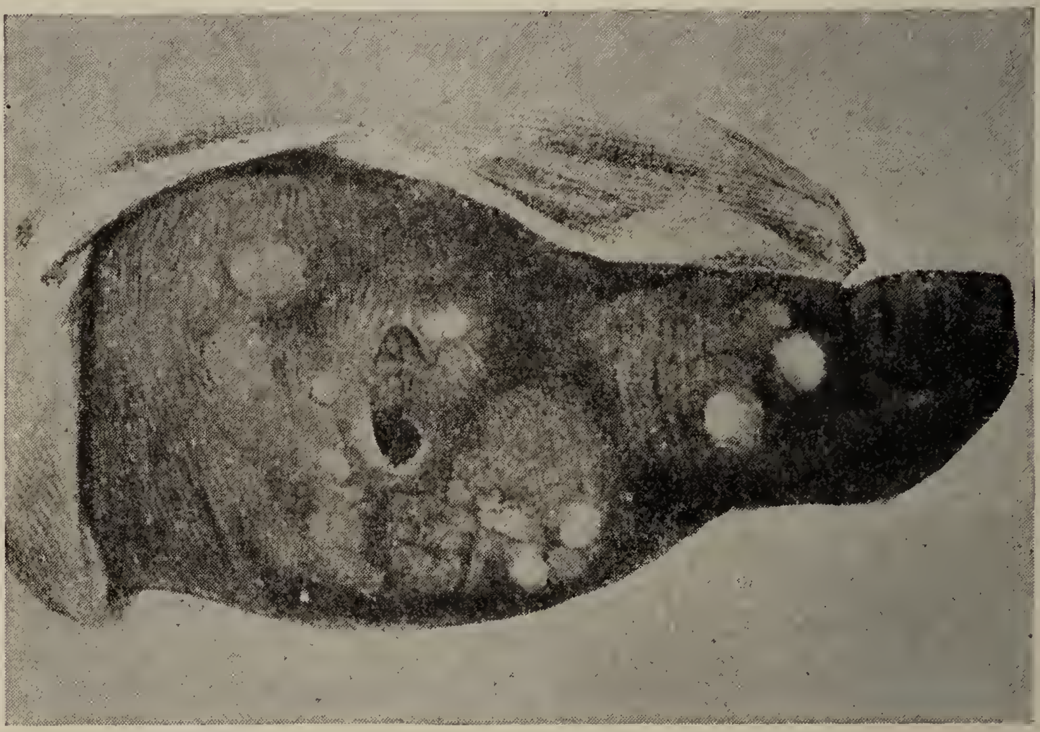

Figure 11—Drawing of a gouty great toe—After Garrod

Operations may be performed on chronically deformed toes, showing changes due to joint disease, as are done with simple deformities due to tight pointed shoes. In such complicated cases, however, relief should not be expected as promptly because obscure "rheumatic" processes continue to act after toe deformities have been corrected. Factors of mechanical pressures and frictions are diminished when toes are straightened however, and patients frequently express their satisfaction after a considerable period of time at relief afforded by their operations.

Infections of various sorts may cause joints to swell, and the great toe is involved quite commonly. A crop of boils, or a chronic tonsillitis may lead to joint inflammations which may settle occasionally in a great toe joint. Social disease produces swollen, tender joints which remain for long periods in certain instances. Finally there are mixed types of joint swellings.

Influence of mechanical pressures of shoes is important in all types. Loose, well fitted shoes and soft leather are needed to minimize pressures and to permit free circulation of blood. Shoe fitters should not be condemned for harmful influences, however, that produce their effects through blood and nerves independently of footwear.

The question may be asked what an orthopedic surgeon can do that a shoe fitter cannot do for these cases. Sometimes orthopedic treatment is not very satisfactory but a more accurate diagnosis probably will be obtained if a medical opinion is sought, also explanations may be given perhaps which will satisfy patients so that they do not attempt needless or harmful experiments.

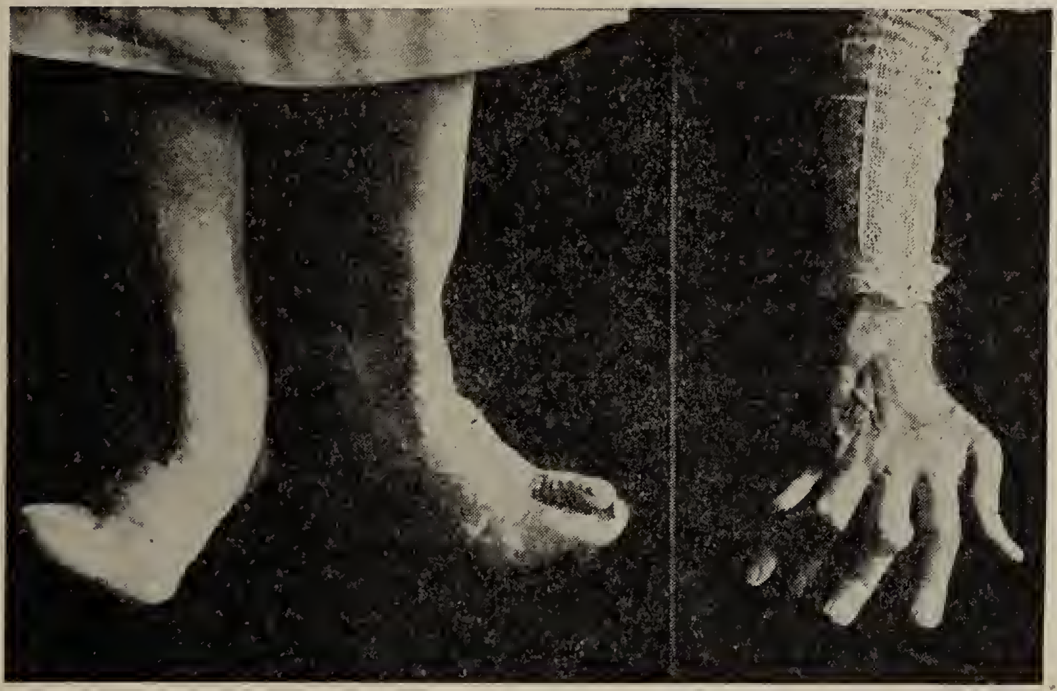

Figure 12—Feet and one hand of a person suffering with chronic deforming joint disease

Limitations of medical treatment ought to be clearly recognized, and promises avoided of miraculous relief. On the other hand, some chronic cases do surprisingly well when obscure causes that have been acting are discovered and corrected.

Shoe fitters do not see customers usually during very acute troubles, but new shoes may be bought before feet have fully recovered and when they are liable to renewed irritation very easily. Shoes have to be adapted to peculiarities of feet temporarily because corrective ideas in shoes at such times would aggravate delicate feet and perhaps cause recurrence of symptoms. Knowledge of recent foot troubles and of their character therefore may be of value to those who fit shoes in order that special care may be taken in the fitting at such times.

CHAPTER VI

POLICEMAN'S HEEL

Sore heels associated with normal appearances of the skin may owe their origins to unrecognized fractures of heel bones, or to disease of heel bones. They may be caused by strains or ruptures of attachments of muscles at the heel, or they may arise from disturbances in nerves distributed to these regions. Policeman's heel is one of the most common of heel affections, and it involves the outer covering of bone together with muscle attachments which are in contact with this bony envelope.

"Policeman's heel" is a name which has been applied to sore heels due to deep seated tenderness on under sides of heel bones. Policemen who are on their feet continually in discharge of their duties have been considered particularly subject to this chronic inflammatory trouble, but probably they do not suffer more frequently than others who walk or stand continuously.

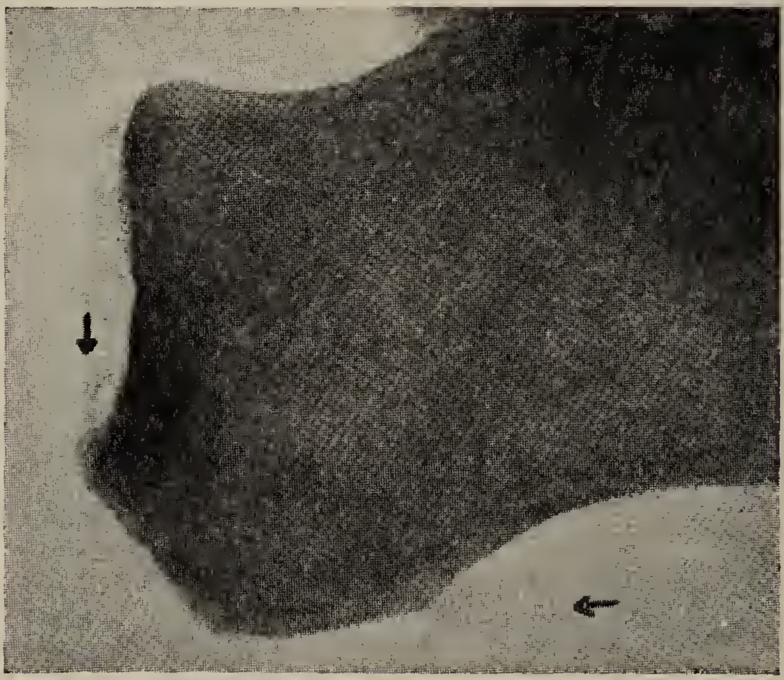

Figure 13—X-ray of heel bone with irritative processes on its under surface and posterior surface at points indicated by arrows

Figure 13 is a lateral X-ray picture of a heel bone that was tender to pressure on its under surface. This patient was a middle-aged housewife who had been bothered with a "stone bruise," as she described her trouble, for a period of two years. No definite injury had been received. She had been bothered also with aches in her feet as well as soreness to direct pressure at this particular spot on the heel. Apparently from her history she had been suffering from unrecognized foot strain. On examination there was no abnormality of the skin over the heel that could be seen. There was definite localized tenderness at the indicated point. Her shoes possessed average smooth heel seats.

Figure 14 is a lateral X-ray picture of another individual's heel that shows a definite bony projection, or spur, in the same relative position on the under surface of this heel bone. There had been no trouble whatever in this instance. The ankle had been broken and the spur was revealed incidentally in X-rays taken.

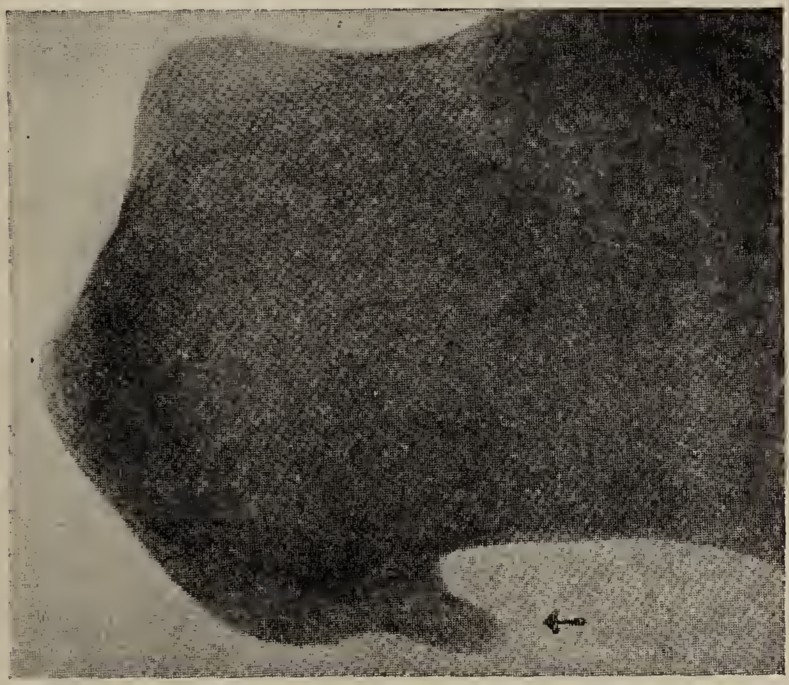

Figure 14—X-ray of heel bone with bony projection on its under surface, at the point indicated by the arrow

Local soreness and a bony projection both are present in many cases. The conclusion has been reached therefore by orthopedists that projections are liable to cause soreness and should be removed when tenderness and spurs co-exist. Numerous persons have had heel spurs chiseled off and have been benefited. Others have obtained less satisfactory results when spurs have grown again in some instances.

Other facts have been sought therefore to account for soreness without projections, as well as projections without soreness, for these need to be understood. An explanation lies in the fact that strong ligaments and muscles in soles of feet possess important attachments at heel bones where spurs are located. There may be soreness on pressure at these attachments of foot muscles in mild grades of foot strain, although no pain is complained of actually at first. In prolonged strains, however, heel tenderness increases until the individual becomes aware of it gradually; and when severe strains of attachments of muscles and ligaments develop, there will be heel soreness whether or not any bony projections exist. Projections may delay recovery theoretically if they become an added source of harmful pressure after soreness has been established first by strains.

Further light can be shed on character of spurs as they are seen in X-rays, from consideration of the anatomy of the heel bone and its muscular attachments as shown in figure 15. There is a bony ridge extending across the under surface of the heel to which muscles and ligaments are attached. See fig. 15—1. In profile view, as seen in lateral X-ray pictures, this ridge will appear as a spur and give erroneous conceptions of its character. Instead of a conical spur, in reality there exists a continuous ridge across the heel.

The well-developed spur of figure 14 is without doubt simply a prominent ridge that represents a marked natural bony variation existing since birth without trouble. If this person should develop strain of foot muscles then the spur would be blamed for painful symptoms without good reason.

Operations performed to remove spurs or ridges destroy necessarily important attachments of muscles and ligaments temporarily while bone is being cut away; and re-attachments in healing may not be as strong as were original ones. If this happens then an operation has done more harm than good. On the other hand, if there has been strain of muscles and ligaments of long duration, scraping away weakened inflammatory tissue gives fresh new surfaces that may heal very solidly during rest enforced afterwards so that definite benefits result.

Recurrence of bony spurs after operations may occur. These may not be true bony outgrowth like congenital spurs, but deposits of hard lime in and about muscle and ligament attachments. Deposits tend to increase anyway with age, and are comparable to similar hardening processes in walls of arteries. They may occur whether or not operations are performed. Operations may accelerate or retard such signs of premature aging of these tissues.

The person's heel shown in figure 13 will have deposits of hard lime about these insertions soon presumably and the bony spur will grow gradually as ligamentous attachments lose their vitality. Similar hardening at the insertion of the strong heel cord can be distinguished faintly already. False spurs will grow probably at both of these regions in this heel.

Two kinds of spurs should be recognized. Congenital ones of normal bone, and false spurs or calcifications in attachments of muscles and ligaments. Congenital spurs without complications are symptomless. False spurs usually are found to have been associated with heel soreness in the past, although the latter may have subsided, leaving a deposit of

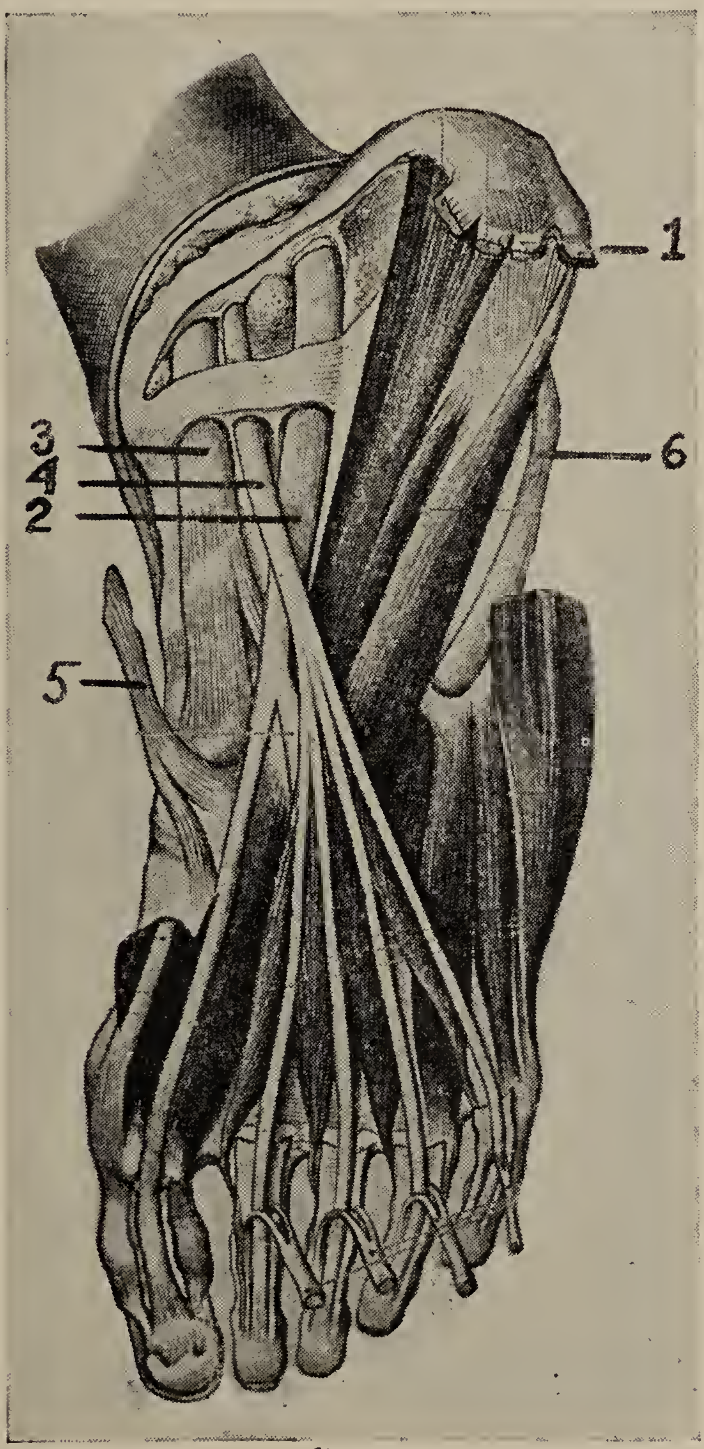

Figure 15—Drawing of foot showing attachments of muscles to heel bone at 1—After Toldt's Anatomical Atlas—Republished by special permission of Rebman Company, New York

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lime to confuse minds of observers. A congenital spur or ridge may grow secondarily by deposits of lime in attachments of muscles located on it when strains develop. Thus mixed types of spurs exist presumably, although distinguishing features between different types may be unsatisfactory.

Sore heels are direct results of strains as a rule, and bony projections are of secondary importance, either representing no practical significance or showing results rather than causes of inflammatory processes.

Slight continuous strains at muscle attachments are not always primary causes of sore heels, for at times there may be definite mechanical injuries, even fractures of heel bones, which hurt muscle or ligament attachments. After such injuries, the strains in ordinary use of the feet may be sufficient to keep up a sensitive weakened condition that started abruptly.

What can be done for sore heels besides surgical operations, and what can shoe fitters do?

There are two things to be done; namely, to relieve direct pressure from weight of the body on heels, and secondly, to relieve strains on muscles and ligaments that are attached to heels.

Direct pressures may be lessened by soft cushion heels; by special plates with areas cut out of them so that these latter protect tender points as a bunion shield acts by transferring all pressure to adjacent regions; or by heel elevations which throw more weight on balls of the feet and thus diminish heel pressures.

Strains of muscle and ligament attachments may be relieved most effectively by keeping off of the feet entirely, a procedure that is impossible to carry out conveniently.

Most persons manage to worry along somehow, retaining their usual activity in part at least, avoiding unnecessary standing or walking which overstrains weak attachments, and by assisting themselves with special heels. Ordinary arch supports that put continuous increased pressure on tense muscles and ligaments in soles of feet may increase heel troubles by the increased strain that they place indirectly on muscle attachments. If, however, muscles and ligaments are relaxed so much that an arch support helps to take weight on the arch without straining heel attachments, then there may be some relief. One policeman whom the writer has had as a patient was benefited decidedly by a combination of high heels and arch supports.

Shoe fitters can try different heights of heels, soft cushions, and stiff shanked shoes. When these fail perhaps a general medical overhauling may be necessary, for patients who are most resistant to treatment often are in poor general condition, being heavy, or anemic, or debilitated. Correction of blood defects, surgical removal of spurs and of chronic inflammatory tissue, and complete rest all may be required simultaneously for success in a few obstinate cases. Severity and duration of abnormal symptoms rather than prominence of bony spurs should determine what treatment is most advisable in most cases.

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CHAPTER VII

FOOT TENDONS AND TENDON TROUBLES

STIFF TIGHT SHOES OCCASIONALLY CAUSE SORENESS OVER HEEL CORDS, OR ON FRONT SIDES OF ANKLES; AND THERE MAY BE FINE CREAKINGS FELT IN THESE LOCALITIES WHICH ARE PRODUCED BY ABNORMAL FRICTIONS BETWEEN TENDONS AND THEIR SHEATHS. NATURAL QUERIES ARISE REGARDING THE NATURE OF TENDONS, THEIR USES, LOCATIONS, AND TROUBLES THAT OCCUR IN CONNECTION WITH THEM.

A tendon is a fibrous prolongation that transmits the strong pull from a large mass of elastic muscle fibres to the tendon attachment at some small area of bone.

Typically, tendons are cylindrical or flattened smooth cords which slide back and forth freely within special smooth sheaths. Some tendons are many inches in length, running from lower leg muscles to tips of toes. Others are very short, thick, and without well developed special coverings.

Figure 16 shows how pull of each muscle fiber is united with others, and all are concentrated into a strong, slender, inelastic prolongation, the muscle tendon. Dark areas in the picture represent masses of muscle fibers lying side by side.

Tendons are not ligaments. Both are fibrous, strong, and inelastic; but tendons run from muscles to bone and transmit muscular force, while ligaments run from bone to bone to bind the latter together. Thin sheets of ligament fibers envelop each joint, and prominent flattened thicker bundles of inelastic fibers blended with these continuous coverings are designated by special names.

An important function of tendons is the changing of directions of mechanical forces which they transmit, in order that such forces may be used most advantageously. Figure 17 indicates how this is accomplished.

Tendons are gathered together rather closely at the ankle as they descend in their courses from the leg; and transverse ligaments bind them down closely. See lig. transversum cruris and lig. cruciatum.

Ligaments have an added function in this instance like that of a pulley which changes the direction of a rope. Tendons slip along smoothly under ligaments when muscles contract, and are not pulled away from the ankle as would happen if they were not restrained. They bear heavily against sides of their sheaths beneath ligaments when muscles pull, and directions of muscle forces being transmitted are changed in directions intended.

There is more pressure and friction against walls of tendon sheaths as they go around curves than along straight stretches. Trouble is most liable to develop at regions of greatest pressure and friction; and therefore special enlargements of tendon sheaths are provided at such points, as are shown in figure 17, which distend with fluid when irritations become harmful. Fluid diminishes friction between a tendon and its sheath, and protects the tendon from harmful outside pressure.

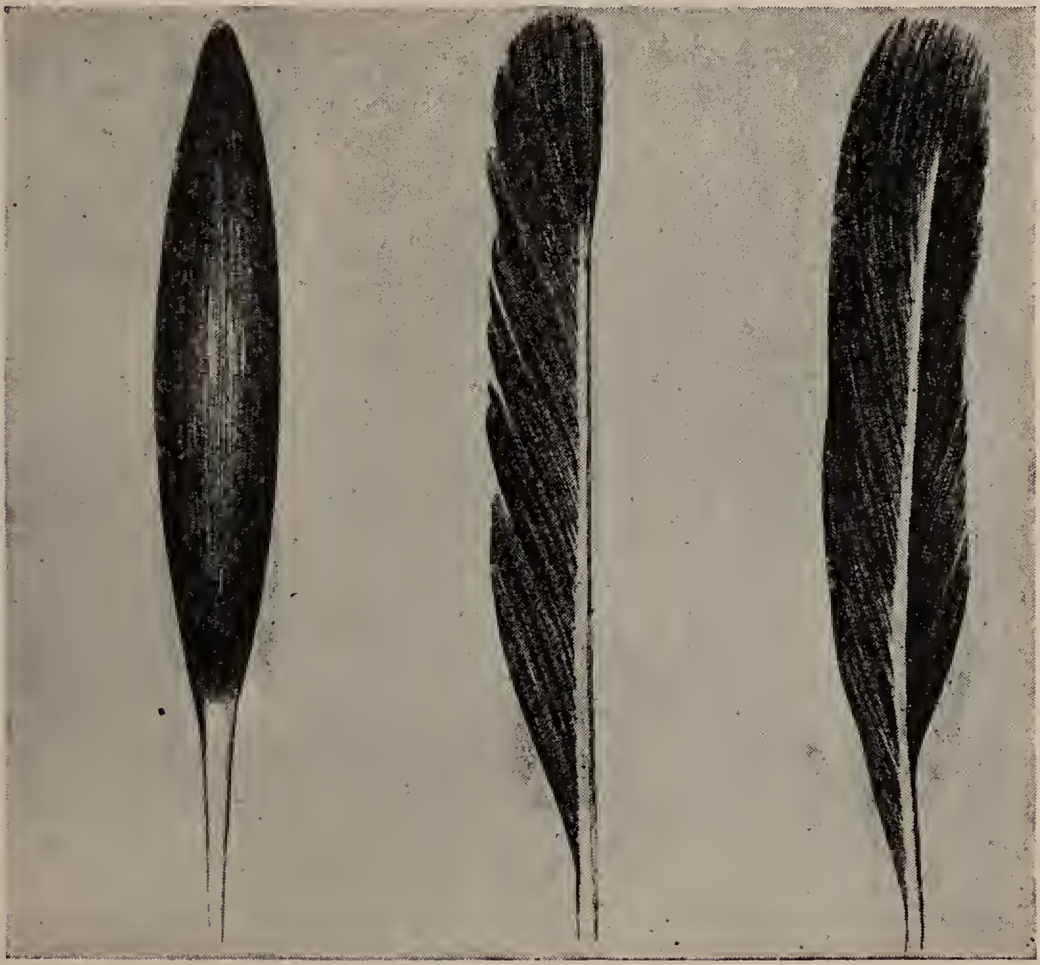

Figure 16—Types of muscles with their tendons—After Toldt's Anatomical Atlas—Republished by special permission of Rebman Company, New York

If a person indulges in active exercise like skating with tight straps pressed very firmly across ankles, there may be noticed on the following day perhaps some tenderness over the front of the instep, as at C or T, Figure 17. The tendon sheath dilatation in figure 17-C is represented

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distended and cut open to show tendons of toes running beneath it. If the fingers are placed over such a tender area there may be felt possibly very fine abnormal rubbing or creaking as the irritated tendon slides along. Creakings soon stop because a little unusual fullness appears which is due to accumulating fluid within the sheath. Fluid relieves friction, and complete subsidence of trouble takes place slowly if no new harmful outside pressures are experienced. Very stiff shoes, laced very tightly, are sufficient to produce soreness in some instances if such shoes are worn continuously.

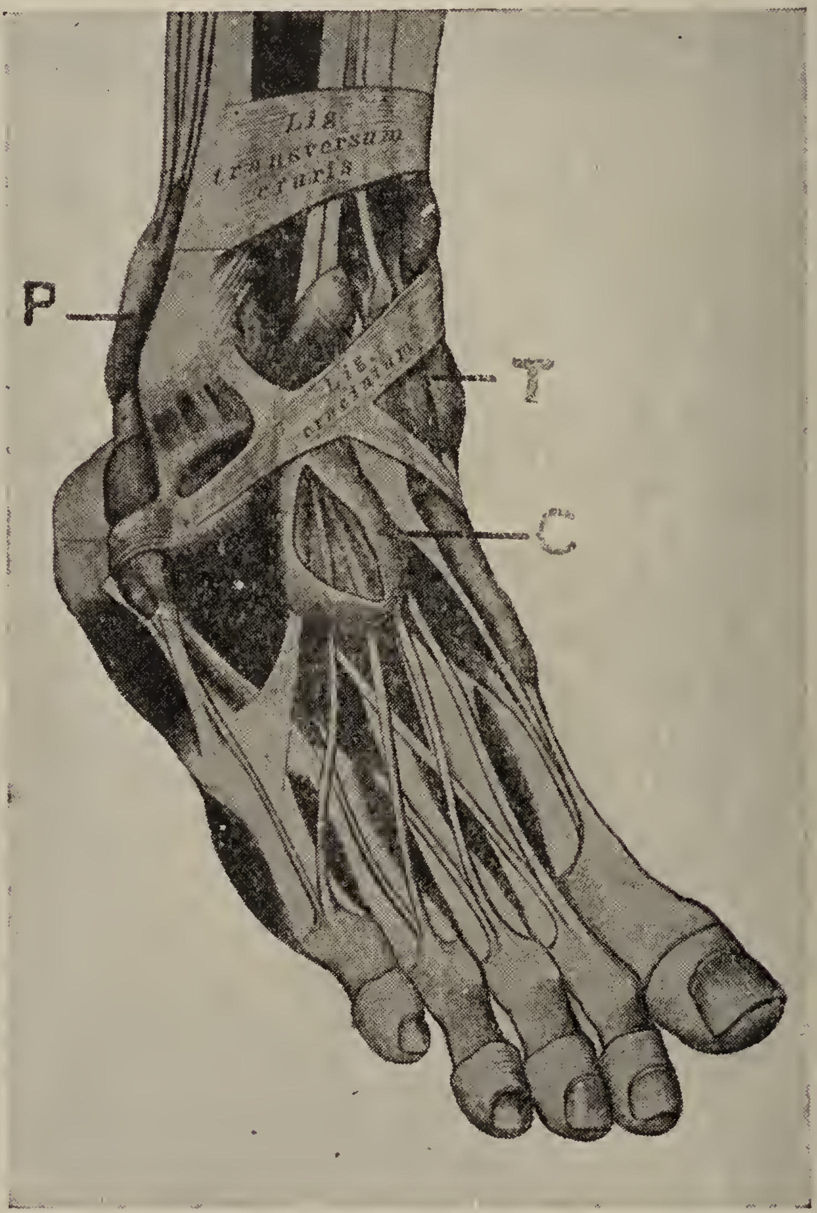

Figure 17—Drawing of tendons and ligaments which bind them down at the ankle—After Toldt's Anatomical Atlas—Republished by special permission of Rebman Company, New York

Distensions of tendon sheath enlargements illustrated in figure 17 show locations of such sacs clearly, but are rarely seen in such extreme degrees in real experience. Similar enlargements of tendon sheaths at wrists occur more frequently perhaps; and from figure 18 may be judged actual appearances of badly distended and chronically inflamed sheaths. This 35-year-old man had had swollen wrists for seven years, yet he was able to work continuously as a mechanic.

His tendons were protected and continued to function with little pain, although their sheaths had become abnormal from a trouble called tubercular tenosynovitis.

Stiffness results when fibrous union takes place between tendons and their sheaths. Such fibrous adhesions form after severe infections, after local disease of bone, or after severe injuries to the feet. Figure 19 is an X-ray of a foot that was caught in machinery. The leg was broken and flesh scraped from the front of the ankle. Toes had become fixed in positions which this picture reveals, because tendons that move toes had become adherent to their sheaths. The broken bone had remained ununited for a long time.

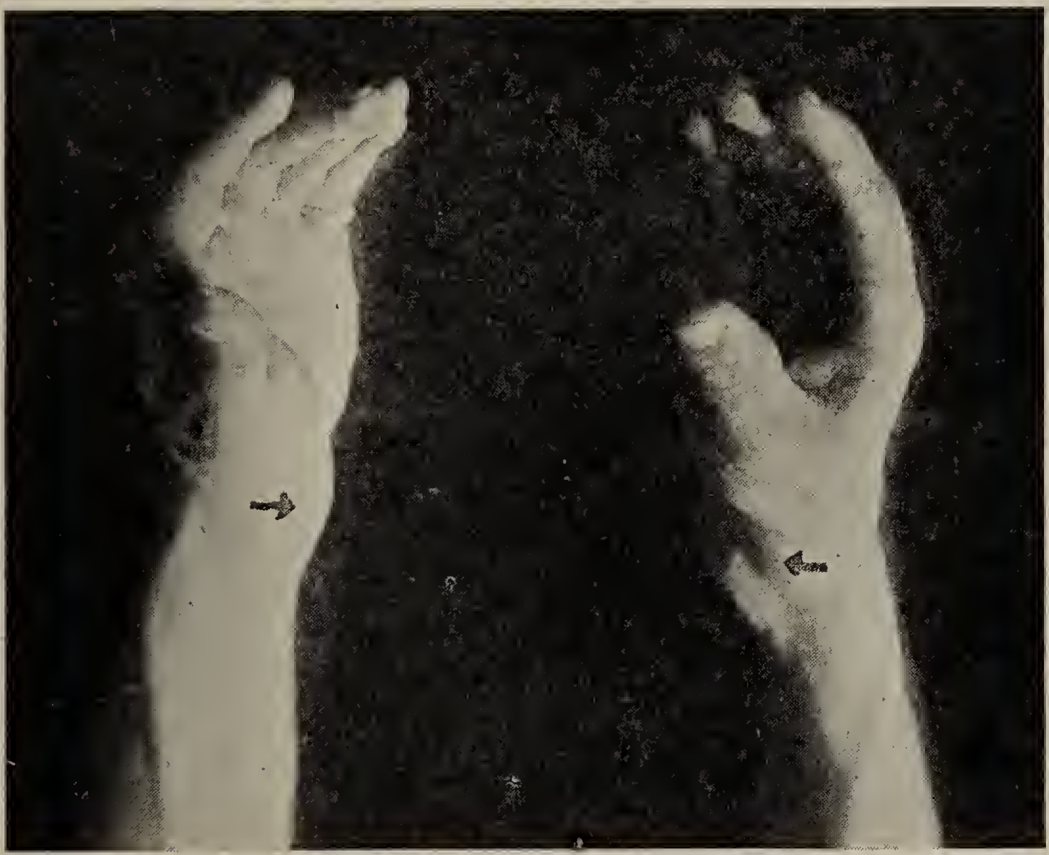

Figure 18—Tendon sheath enlargements of wrist tendons at points indicated by arrows

Heel cords often become sore from pressure of shoes, and there may be creaking over them as at tendons at the front of the ankle. Relief follows promptly usually when low shoes or shoes worn loosely fastened above ankles, are substituted.

Sore heel cords should not be confused with tendo Achilles bursitis of the heel. The latter is accompanied outwardly often by a reddened blistered appearance of the skin at the most prominent point of the

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heel on its posterior surface. There is soreness here as over a toe bunion, and also there is slightly increased prominence due to the deeply situated and distended sac beneath. The heel cord is attached at the lower posterior edge of the heel bone, and there is a tendency toward harmful irritation of the tendon by pressures against the posterior surface of this bone at times. Low shoes fitted short may aggravate pressure at this point. Natural provision has been made for protection, however, at the insertion of this very important tendon. A small sac or bursa is situated between tendon and bone which relieves harmful, uneven pressure by filling with fluid.

This variety of bursitis does not cause trouble of as long duration usually as does bursitis of the great toe, because harmful pressures at the heel appear to be relieved perfectly with greater ease. Occasionally a heel bursa becomes infected, and rarely loose tissue above the heel bone in front of the tendon becomes filled with pus, and the latter may have to be liberated by an opening made through the skin.

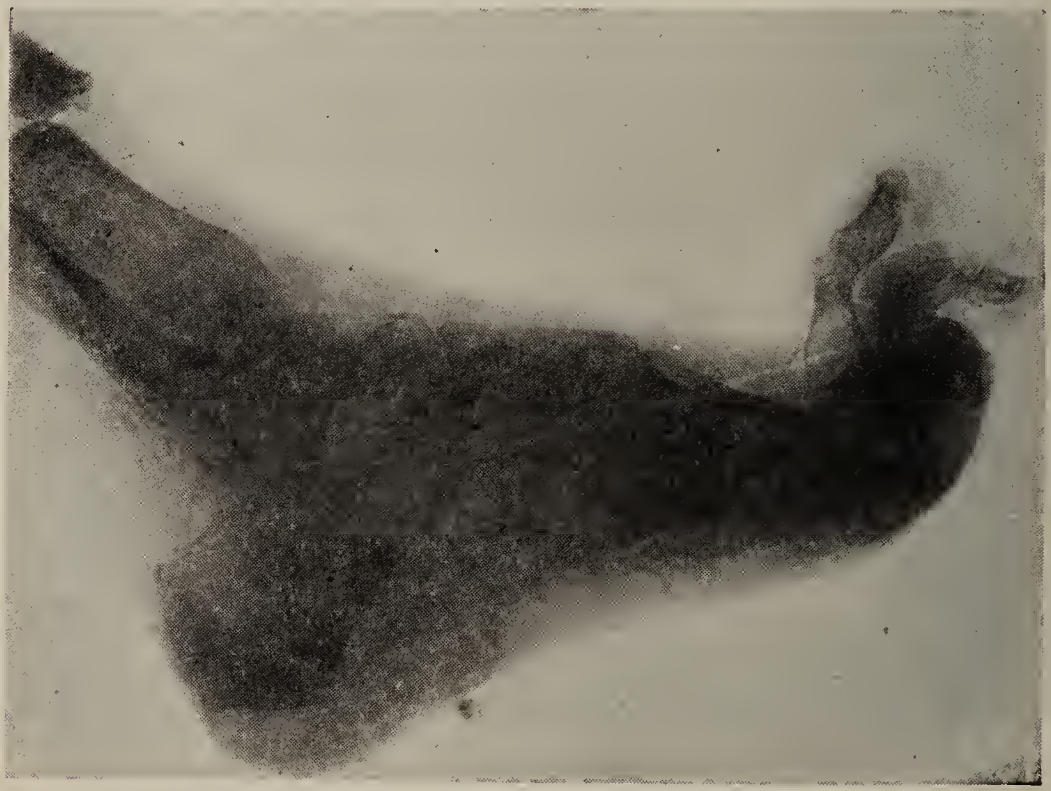

Figure 19—Toe deformities with adhesions between tendons and tendon sheaths following a severe injury

Behind and below the outer prominence of the ankle, there are other enlargements of tendon sheaths as are shown well in figure 17-P. These guide peroneal tendons from peroneal muscles of the lower leg. They may become irritated and develop abnormal frictions in their sheaths. Peroneal spasm, as painful contraction of peroneal muscles is called, may last for many months. Operations have been devised for the condition when it becomes very chronic, but benefits are rather difficult to estimate in advance and operations are not very extensively used. Relief follows generally when the tendons are protected adequately for a sufficient length of time, and if feet are given baths, bakings, and massage in proper ways.

Sesamoid bones are small bones attached to tendons at points where sharp changes of direction are made in transmission of muscular force, but tendon bones will be described separately in another chapter.

Tight shoes frequently aggravate tendon troubles, and therefore, shoe fitters should know something about them, their locations, and signs of palpable creakings which help to identify the defects. It has to be realized, however, that other troubles such as joint inflammations may present somewhat similar pictures. The large majority of cases of acute tenosynovitis, which inflammations of tendons and their sheaths are called, are produced by tight shoes in healthy persons and subside without serious results. At times, however, tendon sheaths are not very resistant, and slight shoe pressures may start chronic progressive conditions that become tubercular in nature.

Orthopedists do a variety of things to tendons. Strappings and plaster casts help to keep irritated parts quiet and permit recoveries by rest. Adhesions with deformities may require operations. Tendons may be split longitudinally and lengthened when heel cords become too short. At other times, in infantile paralysis deformities, it has been found an advantage to utilize tendons of remaining strong muscles in various ways. A tendon may be cut free from its bony attachments, slipped out of its sheath, passed through new channels made in the flesh, and attached to bones in new localities. Such readjustments help to restore the natural balance of partly paralyzed feet, but details of these surgical measures need not be discussed.

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CHAPTER VIII

SESAMOID BONES

SESAMOID BONES ARE SMALL BONY MASSES EMBEDDED IN FIBROUS TENDONS; AND THEY ARE LOCATED AT SPECIAL POINTS WHERE TENDONS PASS AROUND BONY SURFACES. THEY PROTECT TENDONS FROM HARM IN RUBBING AGAINST THE BONES, WHILE SIMULTANEOUSLY THEY PROTECT BONY SURFACES FROM UNDUE FRICTIONS OF FIBROUS TENDINOUS CORDS. SESAMOIDS ARE FOUND IN BALLS OF THE FEET. AT TIMES THESE MAY BE CAUSES OF OBSCURE TROUBLES AND FOR THE LATTER REASON THEY ARE OF INTEREST IN THE PRESENT CONNECTION.

Small circular disc-like bones are found performing special functions in different regions of the body as they are attached to tendons. Such tendon bones or sesamoids are found embedded in great toe tendons. Tendons of little toes may possess them. In the hands they occur in tendons of thumbs and little fingers. At the knee there is the largest and most important one, namely, the patella, or knee pan, or knee cap, as it is called.

The knee cap presents a convenient size for illustration and explanation, and its troubles are familiarly known. Accordingly peculiarities of the knee pan will be utilized to make clear the uses and troubles of toe sesamoids.

Several large muscles on the front side of the upper leg are gathered into a common fibrous prolongation which is attached a short distance below the knee to the lower leg. This attachment is made by the *patella tendon.* The patella itself is embedded in the patella tendon and in the continuous envelope of fibrous tissue over the front of the knee joint.

Figure 20 shows an X-ray picture of a knee joint as seen from the side of the leg. Muscles of the upper leg are located at 1, the patella is situated at 2, the patella tendon at 3, and insertion of this tendon into the bone of the lower leg at 4. Muscular force is transmitted from 1 through 2 and 3 to 4.

If a knee cap is examined on its under side during any operation at which the knee joint is opened, there will be observed a smooth, glistening, bony prominence surrounded by a continuous layer of soft tissue. The weight bearing surface of the patella has a similar appearance to bony joint surfaces against which it rests, and to which it conforms to a certain degree.

When upper leg muscles contract the knee is straightened, and during the pulling process lateral pressure against the knee joint is borne by the small smooth surface of the knee cap. It keeps the fibrous tendon from pressing heavily against joint surfaces, and it acts as a rigid block that minimizes friction in movements of the joint, increasing the efficiency of muscular force expended. It saves the tendon from irritation, also it changes the direction of transmitted muscular pull sharply in a manner that would be done less abruptly and less advantageously if fibrous prolongations of muscles alone swept around bony joint surfaces closely in contact with them all of the way. In figure 20 an intervening clearer space can be seen between the patella tendon and the underlying bone. When the leg is extended the knee pan is pulled upward a little by muscular shortening, and it slips into a hollow, becoming less prominent.

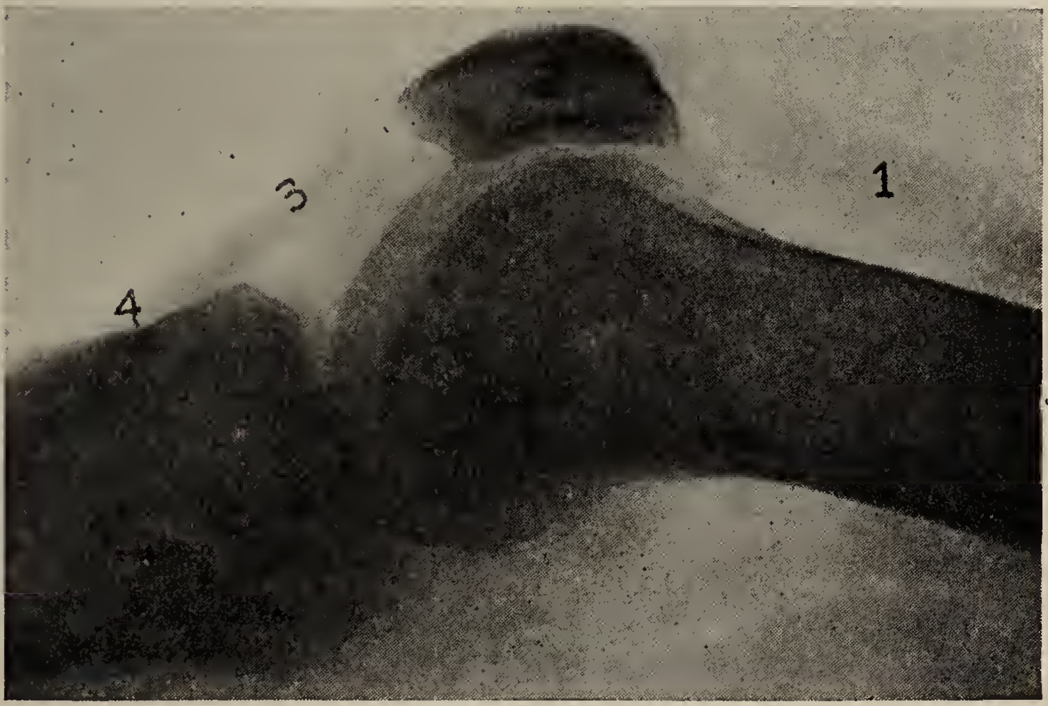

Figure 20—X-ray of a knee joint with its knee cap shown at 2.
Upper leg at 1. Lower leg at 4

Fractures of knee caps are followed often by imperfect repair. Instead of bony union taking place between broken fragments there is fibrous union quite commonly. Figure 21 shows a fractured patella which was broken years ago. Silver wire was used to hold bony fragments together, Figures 21-2, and the wire in this instance has kept

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pieces of the knee cap from separating widely as might otherwise happen, yet bony repair has been imperfect. Fibrous union has taken place which allows the bony deformity illustrated in this picture. There is some weakness of this joint.

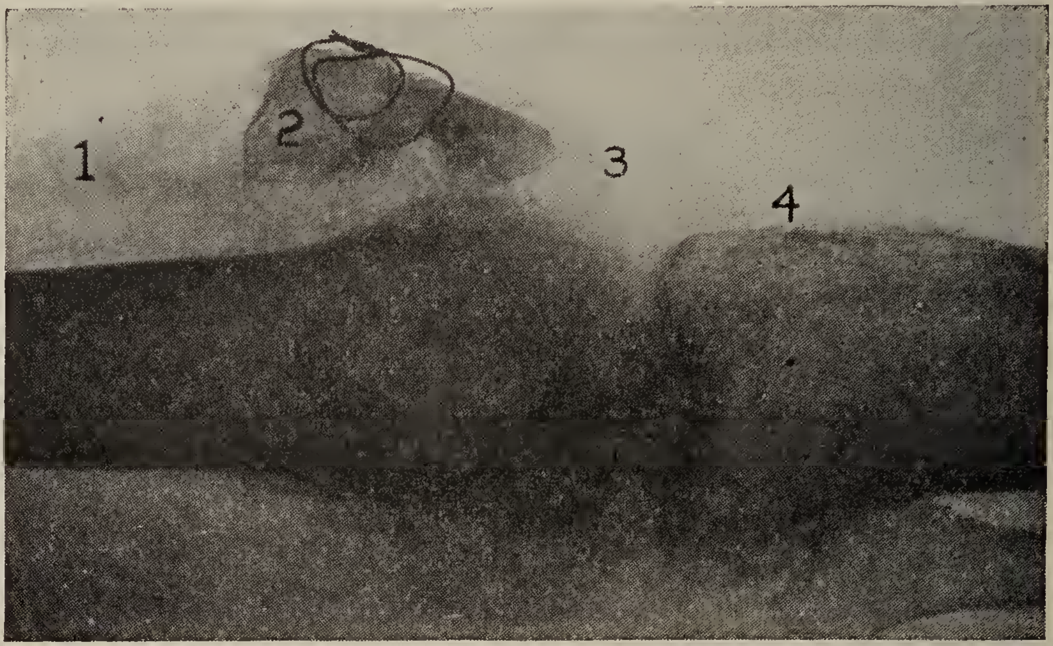

Figure 21—X-ray of a knee joint with a broken knee cap. The latter has been bound together with silver wire

Injury without fracture of the knee cap may produce local pain, and soreness to pressure. There may collect in the joint a protective accumulation of fluid which lessens harmful friction and pressure, and which is called *water on the knee.* The latter subsides again usually as harmful irritation subsides.

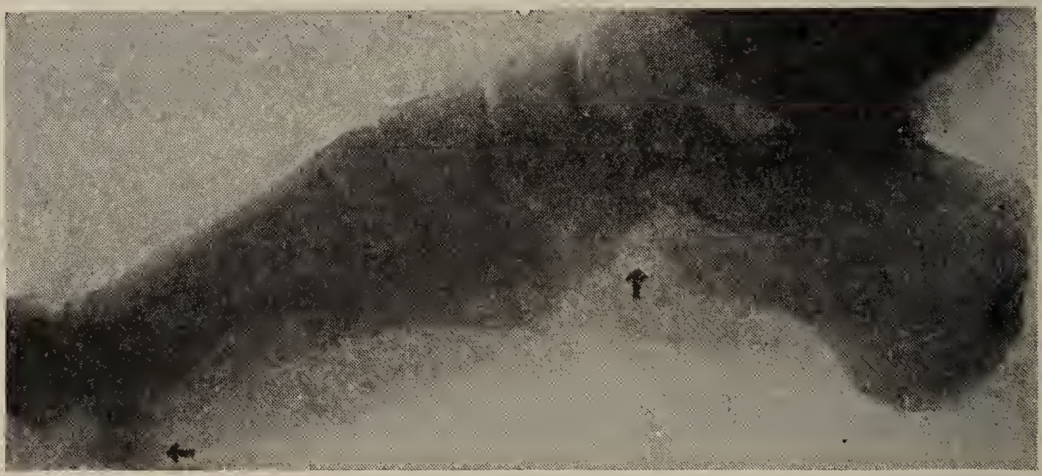

Figure 22—X-ray of sesamoid bones of the foot. A great toe cap bone is indicated by one arrow, while the other arrow shows a small sesamoid bone in the peroneus longus tendon nearer the heel

Figure 22 shows one of the two small sesamoid bones under the ball of the great toe which act like knee caps. They are embedded in two tendons that become attached to the bone immediately after bridging the joint gap at which the sesamoids are located. These toe caps take lateral pressure transmitted by the tendon, and bear more firmly against the underlying bone as the tendon becomes tense. They change direction of the mechanical pull abruptly at the joint, while they protect the tendon from irritation and wear.

Injuries to great toe sesamoids may cause soreness in the ball of the foot if local inflammation is produced. Fractures of sesamoids of toes occur occasionally, and toes may become weaker from this cause as happens with fractured knee caps; but weakness produced by fractured sesamoids of the feet may be favored unconsciously so that the trouble may remain unrecognized.

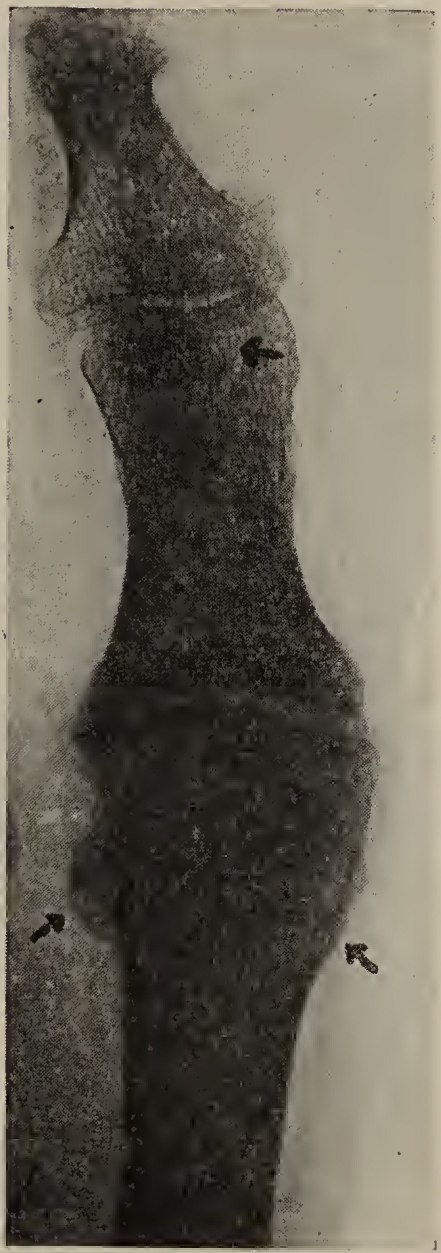

Figure 23—Sesamoid bones of the great toe. These are the rounded dark areas indicated by the three arrows

Shoe fitters and orthopedists have to remember that soreness beneath

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great toe joints is not caused always by calluses or inflammations of usual types within the toe joints. When properly placed pads fail to afford relief, if soreness still continues, then possibility of inflammation about sesamoid bones should be thought of. Motions of toes may keep up harmful irritation under these circumstances, even though direct pressure has been relieved, so that use of sore toes should be minimized as motions of a sore knee are limited in acute knee inflammations.

There are two sesamoids at the base of each great toe, one in each of the two tendinous divisions of the short flexor muscle of this toe; and there may be an additional one at the terminal joint in the long flexor tendon, as shown in Figure 23. A very small sesamoid is shown in Figure 22 which is embedded in the tendon of the long peroneal muscle, at the point where this tendon turns sharply under the outer edge of the foot.

Sesamoid bones of toes have been removed at operations when there has been prolonged soreness, and such treatment has been beneficial apparently in some instances. This procedure is open to theoretical objection that some efficiency is sacrificed and the tendon becomes exposed to future irritation, but patients can get along with or without sesamoids.

CHAPTER IX

HAMMER TOES

When toe bones grow faster than the tendinous cords that move them, there develop hammer toe deformities as increasing shortness of tendons curl up the bones by increasing tension. Hammer toes often are well developed already at time of birth; and frequently they develop gradually during periods of most rapid growth in early childhood. Hammer toe contractures also may be due to other causes. Such toe contractures are treated easily and satisfactorily by surgical methods but this treatment is not invariably required.

Contractions called hammer toes are illustrated typically in third and fourth toes of the foot shown in Figure 24. From this picture it may be observed that pressure in walking on hammer toes is made at extreme toe tips, because middle joints are bent sharply. There are difficulties in straightening toes into normally extended postures.

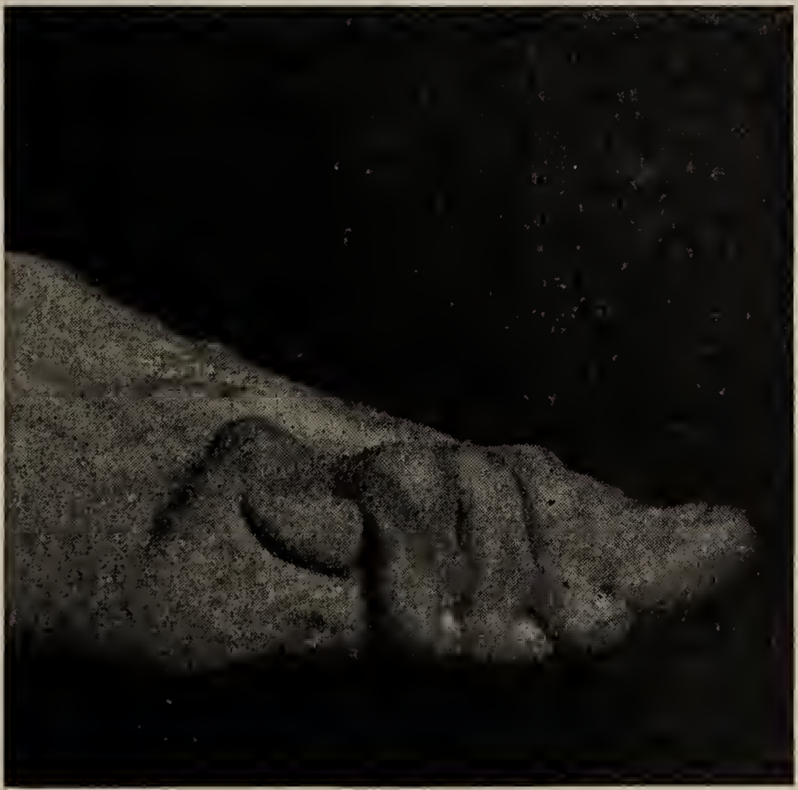

Figure 25—Contracted toes viewed from upper surface—Courtesy of Rice & Hutchins, Inc.

Middle joints often are elevated above the surface of adjoining regions, as Figure 25 illustrates well; or toe tips may be depressed, leaving middle joints level with other toes.

An interesting grading of deformities are exhibited in Figure 24. Starting with normal posture in the great toe, considerable contracture shows in the second one, the third toe is contracted more than the second, the fourth toe more than the third, and the fifth toe flexed so far dorsally that its tip cannot touch at all. A typical deformity is supposed to suggest a hammer.

These deformities are caused by abnormal shortness of tendons, or by contractures of fibrous tissues of tendon sheaths and of other fibrous tissues about toes. Tendons and surrounding fibrous tissues both become involved after a while so that it is usually impossible to state positively whether tendons shorten secondarily to fibrous contractures about them, or fibrous contractures are secondary to primary shortness of tendons.

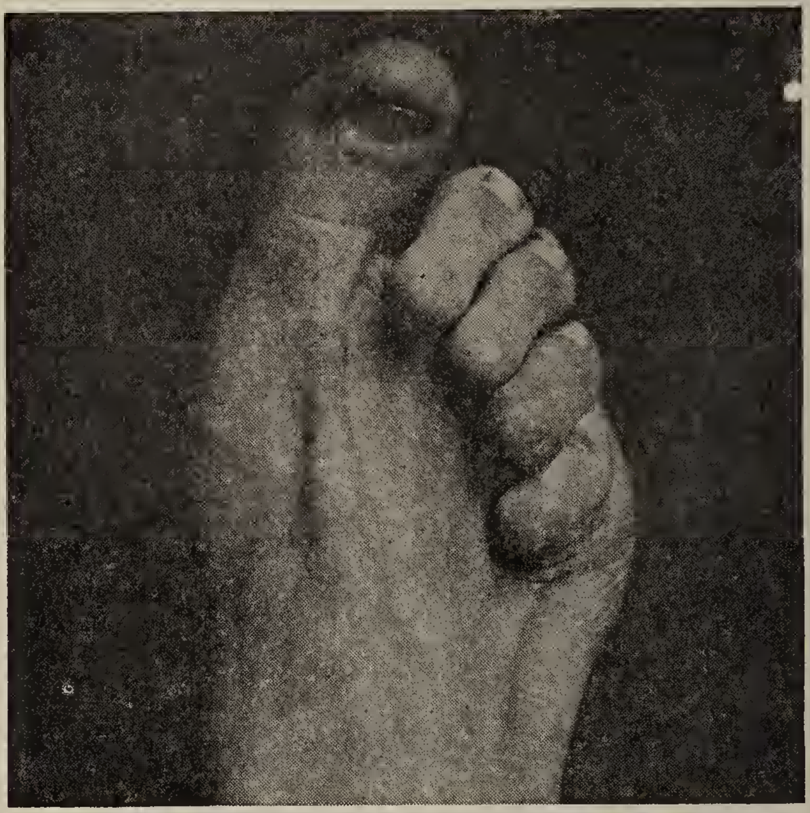

Figure 24—Contracted toes viewed from a lateral position—Courtesy of Rice & Hutchins, Inc.

Tendon shortness and fibrous contractures may be present at birth, and frequently hammer toes develop during early years of childhood as most rapid growth takes place. Several members of the same family may exhibit similar peculiarities. A single toe only on one foot may be bent. Symmetrical deformities of second toes of both feet are common. Multiple hammer toes may be present in a single foot or several may exist in each foot.

Normal arrangements of toe tendons are shown in Figure 26. There is a long extensor tendon (1) attached to the basal joint at its lateral and upper surfaces for the purpose of straightening the toe. There is a long flexor tendon (2) running on the under surface from tip to base which pierces a shorter flexor tendon (3) where the latter spreads out to become attached to the toe near its middle. These latter two tendons are very important in flexing the toe. Small muscles, tendons, fibrous expansions, bursae, are attached or located about the base of each toe, and are mentioned to indicate the complexity of a complete toe mechanism.

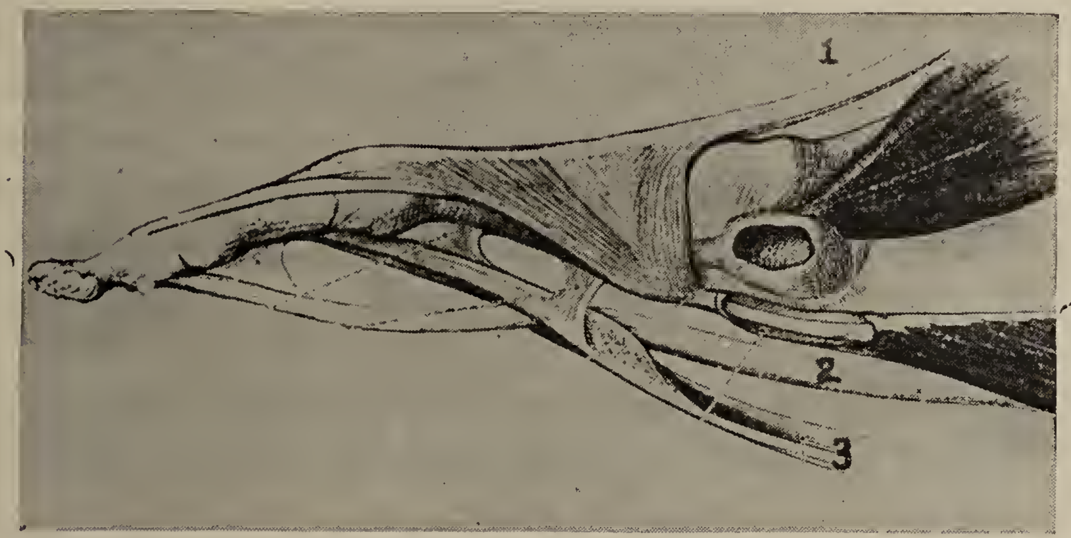

Figure 26—Diagram of toe tendons—After Toldt's Anatomical Atlas; Republished by special permission of Rebman Company, New York

A hammer toe deformity will be produced whenever tendons become abnormally shortened from any cause, or when abnormal contractures appear in fibrous tissues from any cause. Local injuries which produce adhesions between tendons and their sheaths may result in deformed rigid toes. Local infections of feet may cause claw-like contractures with hammer toe deformities. More remotely there may be injuries or diseases of muscles which cause contracture of the latter with resultant shortening of their tendons.

Most typical cases of hammer toe are due to congenital peculiarities, deformities being present at birth or becoming evident soon afterwards when growth becomes rapid. In the Figures 24 and 25, tendons are either too short or bones are too long. When bones grow long faster than normally, or tendons grow more slowly than normal, these contractures are inevitable results of such unequal development.

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It may seem strange that unequal developments should occur without any apparent cause; but, on consideration, it may seem even more wonderful to most persons that complete growth of incredibly complicated human mechanisms is so evenly balanced and perfect in such a large majority of cases. Appreciable defects are seen only occasionally. All parts of the body exhibit slight variations in degrees that interfere rarely with usual functions.

Some hammer toes are slight developmental defects of feet which belong probably in the same general class as more pronounced types of congenital club feet. If muscles, tendons, and fibrous tissues grow rapidly enough to keep pace nearly with bone growth, then slight grades of hammer toe tendencies result, which possibly may be overcome later when rates of bony growth lessen so that lagging tissues can catch up. If unequal developments are more pronounced, then degrees of deformity are greater.

What should be done with congenital hammer toes? Slight tendencies may be combatted by massage and repeated forcible stretchings of toes to help the growing tissues to stretch more rapidly. These measures often prove unsatisfactory nevertheless. Short shoes should be avoided during rapidly growing periods. Operations may be performed if necessary, preferably after complete bony growth has been attained, when lengths of bones may be fitted to tendon lengths.

Let it be recalled that short heel cords are produced in many persons by continuous wear for several years of high-heeled shoes, and similarly short toe cords may be produced by short shoes, especially when strong congenital tendencies toward short toe cords exist. There are many growing children who wear shoes that are fitted too short, who do not develop hammer toes; also some children whose shoes are fitted extremely long and loosely who acquire hammer toes gradually in spite of all care expended on their footwear. Children who have natural congenital tendencies toward toe deformities have these peculiarities aggravated by short shoes; therefore, shoes should be made as favorably long as possible in all cases.

Hammer toes in symptomless, serviceable, adult feet perhaps should not be operated on as a rule until some trouble develops. Soft shoes without stiff toe caps should be worn to prevent irritation. The prominent flexed middle joints and extreme toe tips are liable to become calloused and sore. Nails may thicken, and diffuse inflammation of the skin in front parts of feet may follow prolonged irritation.

An operation on a single hammer toe is exceedingly simple, and results are generally satisfactory. Cutting the shortened tendons is insufficient. Practical experience shows that it is better to open the basal joint of the toe, removing enough bone to allow the toe to lie extended easily, and not interfere with the toe tip or tendons, nor amputate the toe entirely as is done occasionally. Multiple hammer toes are treated like single ones.

After all has been said, there will continue to be individual preferences among different persons. Some will prefer to have their toes corrected quickly and permanently, even at moderate cost and trouble, in order to avoid future difficulties which may develop at an inconvenient time. Others prefer to try stretching, splinting, and exacting treatments which are successful in mild cases to certain degrees. Social positions and occupations of owners of deformed toes always have to be taken into consideration, but generally operations can be advised promptly because of their simplicity and freedom usually from objectionable features when properly done.

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CHAPTER X

CIRCULATION AND CIRCULATORY TROUBLES OF FEET

BLOOD IS PUMPED TO FEET THROUGH HIGH PRESSURE CONDUITS CALLED ARTERIES. LARGE ARTERIES DIVIDE INTO SMALLER ONES. SMALL ONES BRANCH INTO NUMEROUS SMALLER ARTERIOLES. ARTERIOLES DELIVER BLOOD TO THE SMALLEST TUBULES CALLED CAPILLARIES. CAPILLARIES PASS IT ON TO THE SMALLEST VEINLETS. VEINLETS COLLECT THE BLOOD INTO LARGER VEINS WHICH IN TURN CARRY IT AWAY UNDER LOW PRESSURE FROM THE FEET. SHOES MAY PRODUCE CIRCULATORY DISTURBANCES, AND ACCORDINGLY IT IS DESIRABLE FOR SHOE FITTERS TO HAVE SOME IDEAS AS TO PECULIARITIES AND DEFECTS OF CIRCULATION IN THE FEET.

Normal circulation of blood through feet is made possible by normal conditions in arteries, veins, and capillaries. An idea of the elaborate system of veins and arteries may be obtained from Figure 27. This shows an extensive superficial network of veins. Arteries are represented in a darker shade, and they are fewer and smaller than veins in this picture. Veins possess many more connecting branches than arteries.

A general idea of the perfect distribution of blood to all tissues simply needs to be presented, a distribution that includes bones, ligaments, tendons, muscles, joints, skin, subcutaneous tissue, nerves, and even walls of blood vessels themselves; for these latter are supplied with small branches to keep their walls strong and healthy.

Perfect final distribution is accomplished by small capillaries which form extremely fine net works of tubes as continuations of branches of smallest arteries, or arterioles as the latter are called. Capillaries are thin walled and leaky. They are designed to be of this character. They continue on to merge into smallest veinlets, which in turn combine into larger veins, and finally unite into few comparatively large ones that carry blood away from feet.

Figure 28 is a greatly magnified drawing that gives a rough idea of how numerous the capillaries are, and how every spot within tissues is reached. In this picture very small branches of arteries are represented in a dark shade, and very small branches of veins in light shade. Both are shown against a general ground-work of fine capillaries.

Considerable pressure is required to force blood through such extensive networks of fine tubes in uniform manner. Blood flows through arteries therefore under a high pressure which is maintained by steady pumping of the heart. Blood pressure in veins is lower, so low in fact

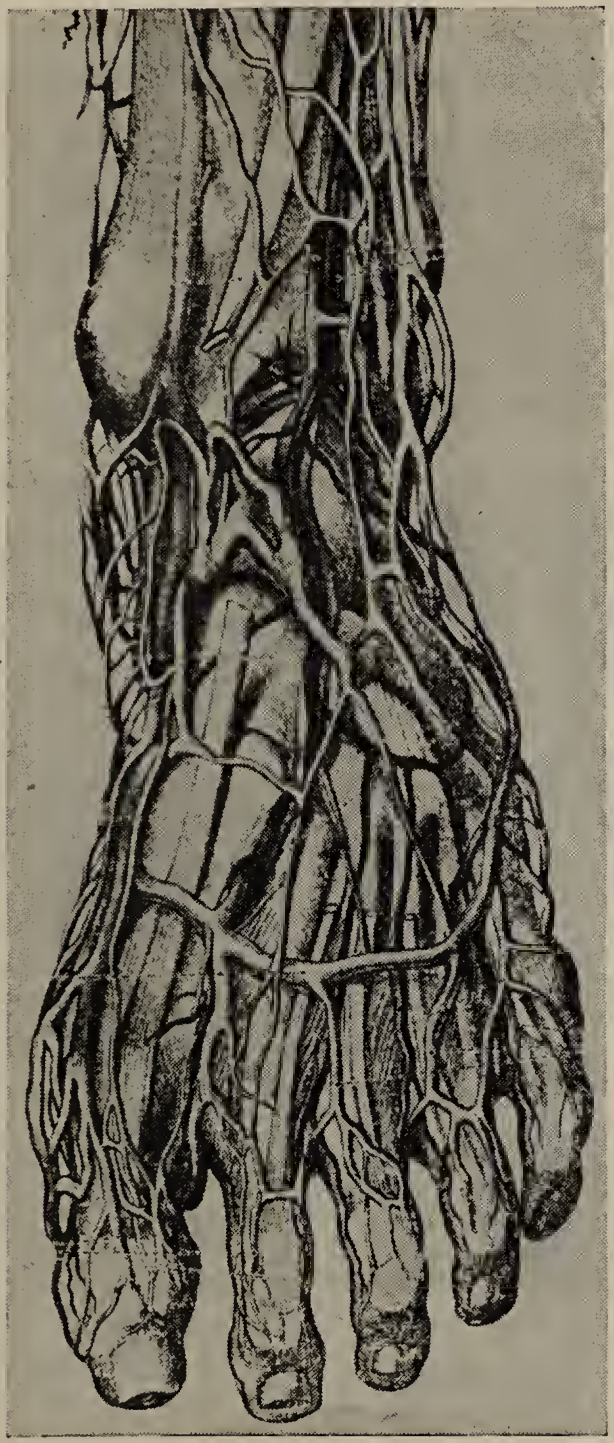

Figure 27—Some of the veins and arteries of the foot. Veins are represented in light color and form a network of many branches. Arteries are represented in dark color. After Toldt's anatomical Atlas Republished by special permission of Rebman Company, New York

that veins are provided with delicate one-way cup-like valves to prevent back flow when veins are squeezed by strong outside forces.

Even distribution of blood to extensive capillary fields is accomplished beautifully by means of contractile walls of arteries. The caliber of an artery can be increased quickly so that the region to which it delivers blood can be flooded when necessary; or muscular walls of arteries may contract to cut down the volume of blood delivered. There are continual changes going on in artery walls throughout the body from time to time, some arteries dilating temporarily, others contracting.

The mechanism of control of the blood flow is intricate and interesting. Walls of arteries have layers of muscle fibers in them. When these muscle fibers contract they diminish the bore of blood vessels, when they relax the caliber may be increased. Muscle fibers are made to contract and to relax by means of delicate nerves in walls of blood vessels. There are sets of nerves that produce narrowing of arteries while others produce widening of the stream. Nerves are controlled from central nervous stations. We are not conscious of this complicated automatic muscular-nervous control of our circulations by which various parts of the body receive variable quantities of blood as their needs

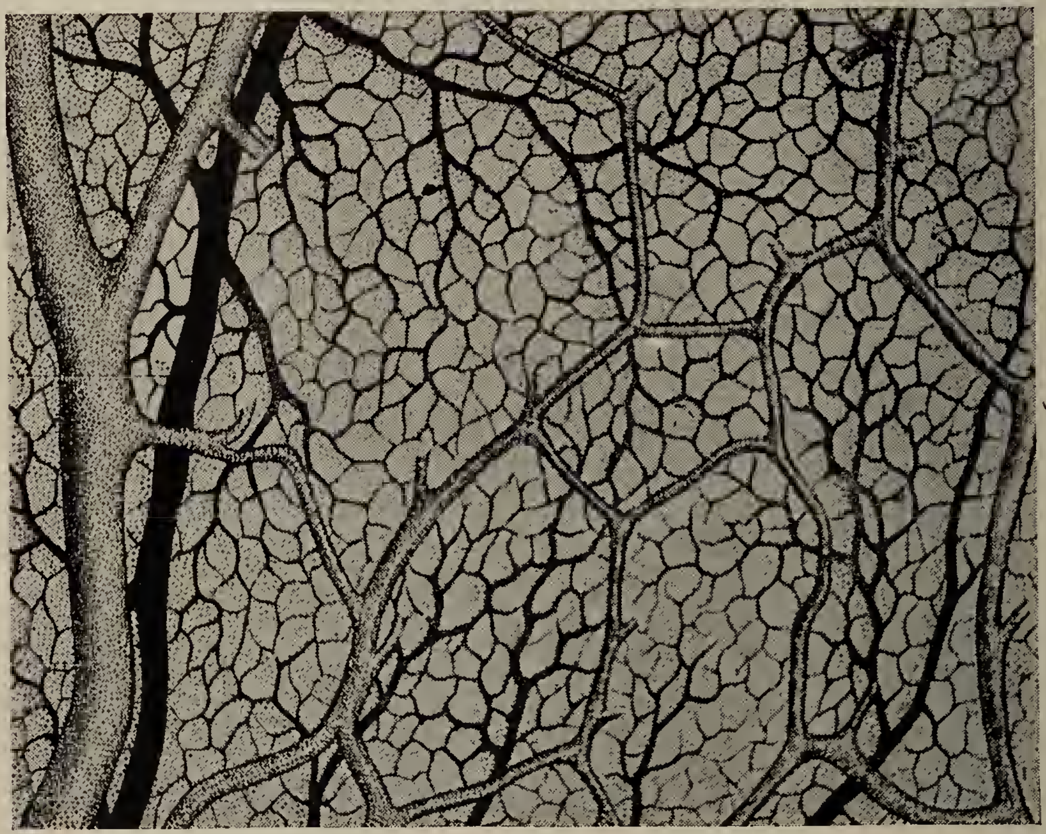

Figure 28—Greatly magnified drawing of the network of smallest blood vessels which are called capillaries. After Toldt's anatomical Atlas Republished by special permission of Rebman Company, New York

demand. Nor is it surprising that such a delicate mechanism gets out of order at times.

Some persons are troubled with fingers or toes that become white and cold and painful. Such troubles are due to difficulties in the control of blood flow which are called *vaso-motor* disturbances. One toe may become cold and white, and an adjacent one may be warm and pink.

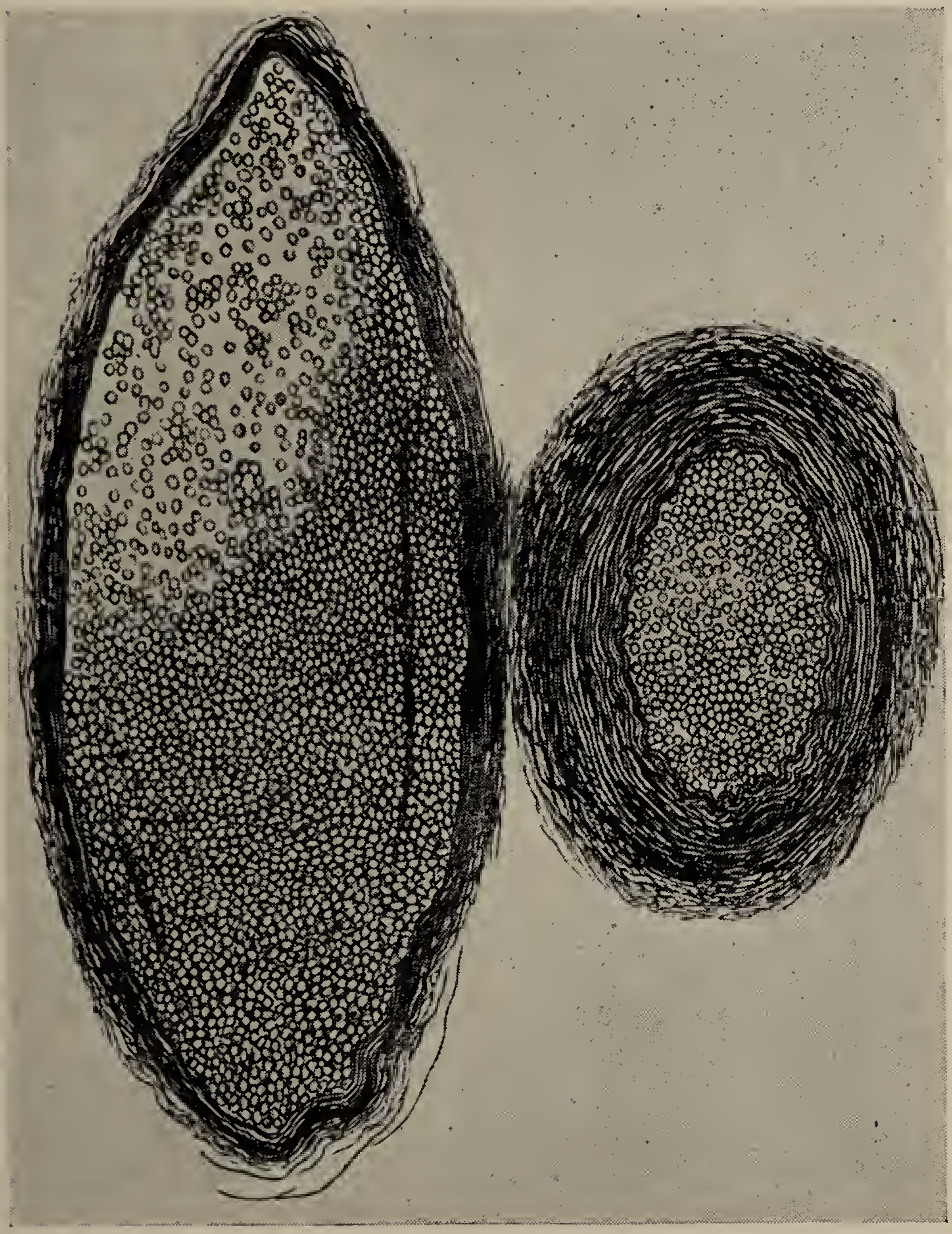

Figure 29—Greatly magnified drawing of cross sections of a small artery and a small vein. The artery is the smaller vessel.—After Toldt's Anatomical Atlas—Republished by special permission of Rebman Company, New York

In the first instance there is too great constriction of the small arteries which supply the toe, while in the second toe there may be apparently useless flooding with blood. Severe types of such troubles may exist and even cause gangrene of toes in rare instances.

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Figure 29 is a drawing of a cross section of a small artery and a cross section of a small vein. The picture is magnified greatly. It shows the relative thickness of walls of arteries and veins. Arteries are smaller than veins usually, and arteries possess many more muscle fibers within their walls. The thin-walled vein is represented as partly filled with blood corpuscles while the artery appears completely filled with them. Blood corpuscles are shown as numberless tiny circles in the drawing.

Hardening of arteries, or arteriosclerosis, is a common trouble which comes on gradually in old age. Sometimes it develops more quickly in some persons who appear to have been provided with poor tubing at birth for their blood vessels. In consequence their arteries age rapidly. In other instances, hardening of arteries is produced more rapidly as a result of habitual use of strong alcoholic beverages, or continual over-eating, or from other causes.

Hardening is produced by deposition of lime in their walls and this makes them more brittle. Usually their linings show changes also, and may become thickened slowly to such a degree that an artery becomes almost a solid cord with an extremely small bore running through it. Blood may not be able to get through it in sufficient quantities to keep tissues alive, and then gangrene slowly makes it appearance, as is seen in toes in aged persons not infrequently.

Figure 30 is an X-ray of a foot of a middle-aged man who was an habitual drinker. He broke his leg (see large arrow) while under the influence of alcohol, and when the picture was taken there was revealed a hardened state of arteries which is just visible along the course of the small arrows.

Capillaries allow substances in circulating blood to soak through their thin walls. There are interchanges of substances between tissues and the blood at capillaries which are of vital importance to the tissues.

Veins are subject to diseases. Thin walls of small veins often become abnormally enlarged and the condition known as varicose veins results. Veins of feet and legs are particularly susceptible to these changes which exist in variable degrees.

Shoe fitters are interested in effects of shoes on circulation of the feet under normal conditions, also when there are circulatory disturbances. If shoes are worn short and tight habitually, one common result is chronic inflammation of the skin. As a result of skin irritation there are dilatations of small blood vessels of the skin, and feet become hot, swollen, burning, uncomfortable, congested. Massage and baths may afford quick temporary relief, but larger, looser shoes should be fitted for permanent comfort.

Purposeful snug lacing of shoes to prevent feet from pushing forward may be advantageous in relieving back pressure on toes, but this constriction may interfere with superficial circulation if carried to extreme degrees. A few susceptible persons may develop tendencies toward chilblain as a result.

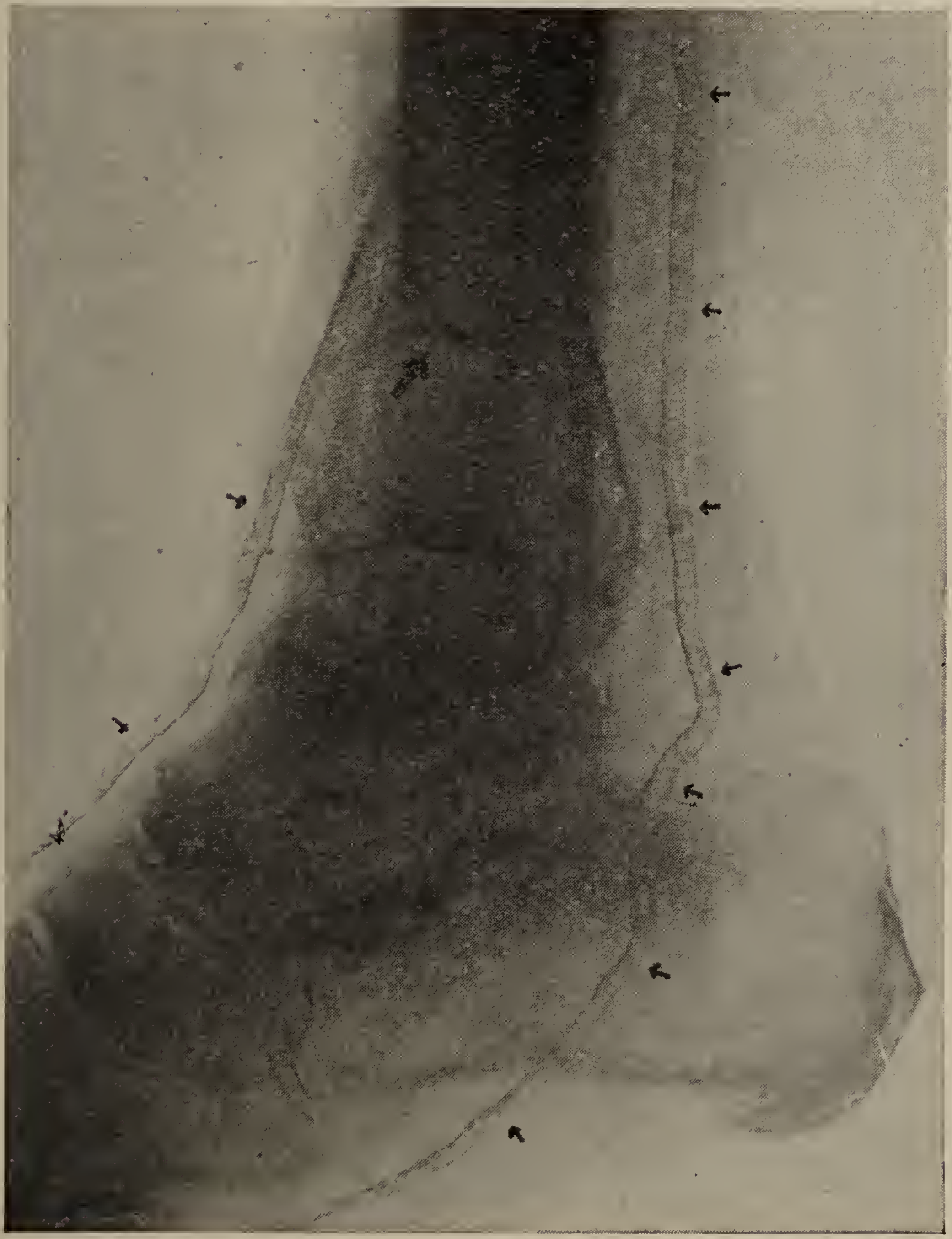

Figure 30—X-ray of hardened arteries of ankle and foot. The engraver has retouched the outlines of these vessels slightly to make them more distinct. The large arrow indicates a fracture of the leg bone

Tight shoes should be avoided when, for any reason, there are obstacles to normal flow of blood as in arteriosclerosis, or in derangements of arterial control shown by so-called "dead" cold, white toes. Tight shoes on the other hand may be useful in supporting weakened veins, or weakening ligaments or muscles.

Puffiness of skin of feet, due to heart and kidney diseases, will not be discussed, except to state that underlying causes of these troubles should receive attention. Tasks of shoe fitters become difficult and unsatisfactory under these conditions because of continual changes in sizes of feet from day to day.

CHAPTER XI

NERVES OF THE FEET

Numerous nerves convey nervous impulses, or messages, to and fro between feet and nervous centers in the spinal cord. Nerves exert profound influences directly or indirectly on the growth and conditions of foot tissues:—on muscles, blood vessels, bones, joints, and skin. Nerves or nerve centers may become abnormally active sometimes themselves; so that persons exhibiting such peculiarities may really suffer from, and complain about, shoes or shoe fittings that are entirely satisfactory to average normal individuals. Shoe fitters have to realize that all painful feet are not caused by local foot troubles, and that shoes will not relieve all conditions.

When a foot becomes painful, usually nerve fibers somewhere in the affected member are sending in a warning to a central nervous station, that local trouble exists. There are important exceptions to this statement, however, that will be explained later.

Various kinds of nerves perform variable tasks in each foot. There are *motor* nerves which run from central stations of the spinal cord through tissues of legs to terminate in muscles that control foot motions. By means of motor nerves feet can be moved at will. There are *vaso-motor* nerves in blood vessels which contract involuntary muscle fibers of vessel walls, and these act automatically without knowledge of the individual as requirements demand. There are *sensory* nerves which carry messages, or nervous impulses as they are properly called, in reverse direction from motor nerves. Sensory nerves convey nervous impulses from feet to spinal centers. There are various kinds and combinations of sensations carried, as sensations of touch, pain, numbness, itching, burning, heat, cold.

How sensory nerves are distributed to all parts of the skin of feet is shown in Figures 31 and 32. Notice the thick pads of fat in which these nerves run beneath the outer skin of the sole of the foot. There are various other nerves within deep tissues that convey sensations

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from joints, bones, muscles, and blood vessels; but in the present connection it is not necessary to enter on discussion of exact distributions of nerves.

All nerves may act normally, or some of them may act abnormally at times in transmitting nervous impulses with unusual ease or unusual difficulty. Motor nerves and their nerve cells may be dulled in function so that muscles to which these nerves run become partly paralyzed. If motor nerves on the other hand convey nervous impulses too readily, there may be spasm of muscles.

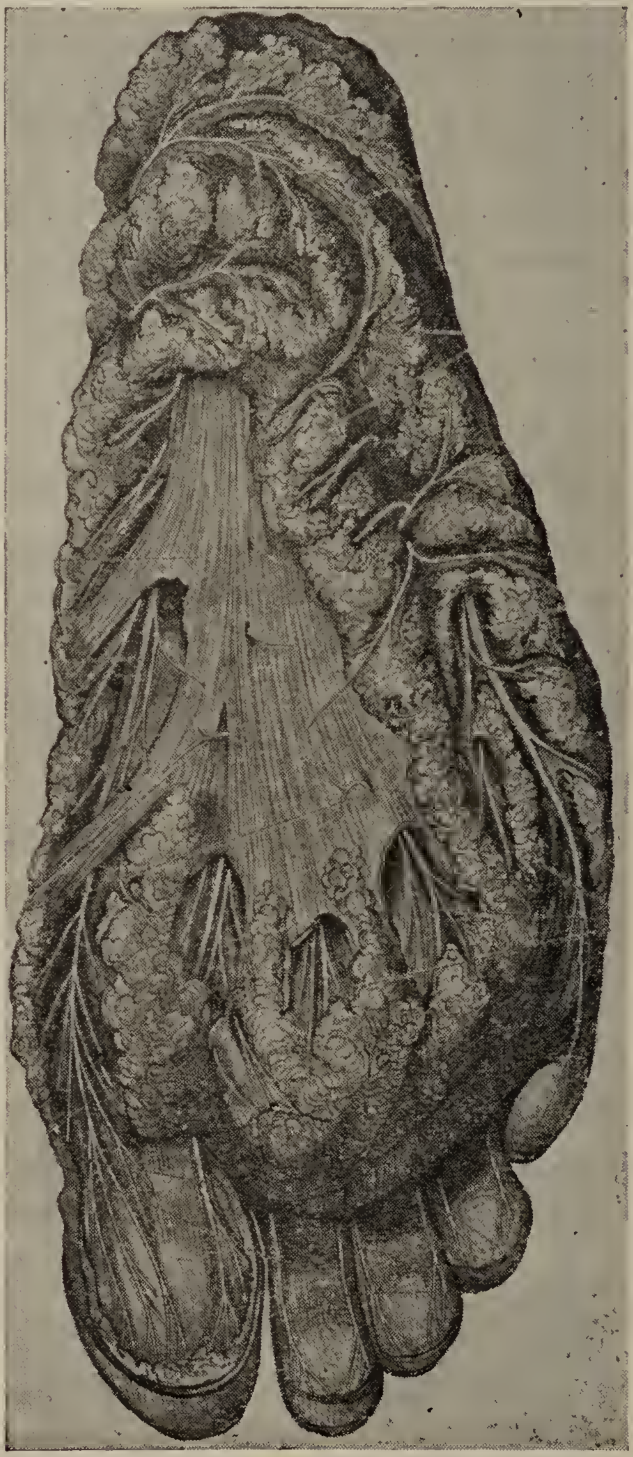

Figure 31—Nerves of the bottom of the foot as they appear under the skin —After Toldt's anatomical Atlas—Republished by special permission of Rebman Company, New York.

When sensory nerves are dulled, numbness or diminished sensations of other sorts are noticed. Feelings locally may be lost entirely in some nervous diseases, and damage to skin may result in consequence of absence of warning painful sensations. Sores may develop at points of greatest pressure on heels or balls of feet when sensations are dulled.

If sensory nerves become excessively sensitive, as happens not infrequently in nervous disorders, then ordinary pressures of shoes may become uncomfortable so that tasks of fitting shoes may be very difficult. Even with normal individuals who make no complaints there may be fairly wide variations in sensitiveness of skin of the feet.

Causes of normal, sub-normal and super-normal sensitiveness of nerves have to be sought in nervous tendencies sometimes present at birth. Certain persons have average nervous functions from the outset, while others show early weakness or unusually strong, healthy function of nerves. During life much depends on the state of an individual's health from time to time, on presence or absence of recurring nervous symptoms of variable grades which develop in response to variable conditions of blood, personal habits, and so on. Nerves that were weak in the beginning may become strong gradually; or those which were

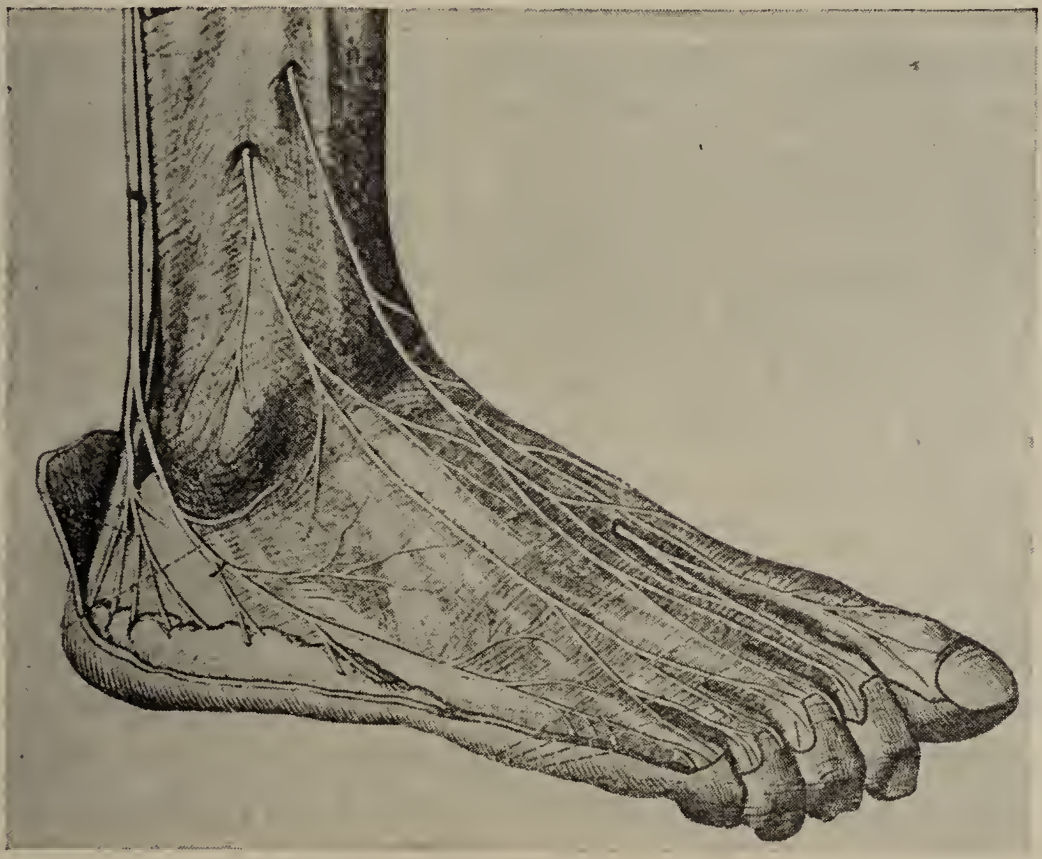

Figure 32—Superficial nerves of the ankle and foot—After Toldt's anatomical Atlas—Republished by special permission of Rebman Company, New York

originally strong may become weakened and delicate from unhygienic modes of living.

Pale, tired, debilitated persons often have so-called neurasthenic pains of shifting nature in backs, arms, shoulders, necks, legs, or feet. Nervous systems of such patients are in a condition that approaches the transition line between normalcy and a pathological state. In such people slight pressures of shoes may cause as much real discomfort as very tight shoes produce on very healthy individuals.

Mistakes should not be made of attributing painful symptoms to flat feet wholly when functional defects of nerves constitute the principal trouble. Changes of shoes, arch supports, exercises, may fail to give relief until underlying nervous instability is overcome. Muscles and nerves apparently may be involved equally if poor circulating blood influences both of them in unfavorable ways to produce muscle weakness and nervous weakness. One physician may emphasize muscle strain while another may call attention to nervous peculiarities, and each may be right as far as he goes with the complete explanation.

Painful symptoms referred to feet and arising from causes acting outside of feet, can be understood clearly from leg amputations. Amputations may be followed by sensations of pain referred to feet after the latter have been removed. Central receiving stations do not discriminate between incoming nervous impulses that have traveled entire distances from feet and those which come from amputation stumps. Centers register simply that painful messages have been received through usual channels, and they are interpreted as evidences of trouble in regions usually regulated by nerves in question, whether feet have or have not been removed.

Painful impulses may be transmitted along usual sensory pathways from points outside of feet when there have been no amputations. As a result of pulling or pressure on incoming sensory nerves from lower extremities very near to their destinations inside the bony spinal canal, there may be painful symptoms in thighs, calves of legs, and heels of feet at times caused from strains of lower regions of backs. Sensory nerves which have been squeezed or stretched, send in reports of pain which are interpreted, as in amputations, as coming from regions from which nerves usually collect sensations. Relief from leg or foot symptoms has to be sought in proper treatment of back strains, in these instances, not in local treatment of legs or feet.

Sensory nervous pathways from feet to the spine may be interfered with in other ways than by mechanical pressures and tensions. Painful impulses may be aroused by harmful influence of faulty circulating blood. Habitual use of alcohol in large quantities is liable to produce alcoholic neuritis in nerves of the extremities. In diabetes, there are liable to be disturbed sensations in legs and feet from similar obscure effects of circulating blood on sensory nerve paths. Nerve centers themselves may become unbalanced and register impressions as coming from extremities that never started in the latter, as a result of the influence of poor blood on nerve cells.

Shifting pains in different parts of the body due to debility, anaemia, loss in weight, have been alluded to earlier. Blood defects of anaemia and debility, appear to be important in producing neurasthenic pains of temporary character. One patient who consulted the writer complained of vague foot pains for which he had purchased five new pairs of shoes in a short time. He also had occasional pains in his wrists, and his eye muscles became fatigued quickly. He complained of depressed feelings which increased and finally led to an attempt at suicide.

Morton's toe is a name given to a local painful disturbance in third or fourth toes usually. Sharp localization and severity of symptoms suggest that a single sensory nerve in the ball of the foot is being pinched between bones, painful feelings being referred in usual manner to the region from which the particular nerve normally collects sensations. Proper treatment consists in relieving the harmful pressure; and this may be accomplished at times by shoes, by anterior arch pads, by operations, or by physio-therapeutic measures.

Main facts that shoe fitters need to realize clearly, are that various causes in other regions of the body may produce aches and pains in feet; and that it is useless to try to relieve symptoms by footwear alone which are derived from such origins, although careful fitting of shoes always is indicated. Flat feet, on the contrary, may contribute to development of painful symptoms at a distance in knees and backs as will be explained in another chapter.

CHAPTER XII

MUSCLES THAT MOVE THE FEET

Muscles are arranged in groups so as to hold, or to pull, the various foot bones in various directions. They act as elastic cords or bands that are constantly under more or less tension even when all muscles are voluntarily relaxed. Single muscles under normal conditions have to be neither too strong nor too weak; for then there would be disarrangements among the variously opposed muscle tensions. Feet would be pulled or held in unusual postures. Such abnormal states develop when certain muscles are paralyzed in infantile paralysis, and strong muscles remaining then pull feet into typical deformities. This fact helps to make clear that foot shapes as well as foot functions are dependent on integrity and normal balance among numerous muscle groups.

It is an advantage to a shoe clerk to know roughly the locations of muscle groups and signs of muscle strain in order to fit shoes properly.

This topic is one of the most complicated and important that shoe men have to consider. It will be separated into three headings for clearness and convenience, namely, general arrangement of foot muscles, minute structure of muscles, and muscle physiology. Complex details will be presented as simply as possible, and they must be comprehended thoroughly to allow proper understanding of the topics which follow relating to flexible shoes, stiff shoes, and arch supports.

General Arrangement of Foot Muscles. More than 20 muscles are used to regulate all movements of a foot, and many of them are divided further into several slips for movement of individual toes. Accordingly there are very many points in foot bones which are subjected to pull of elastic muscles in various directions. A few important groupings of muscles will be mentioned and explained with aid of illustrations.

Strongest foot muscles are not in the feet at all because the large

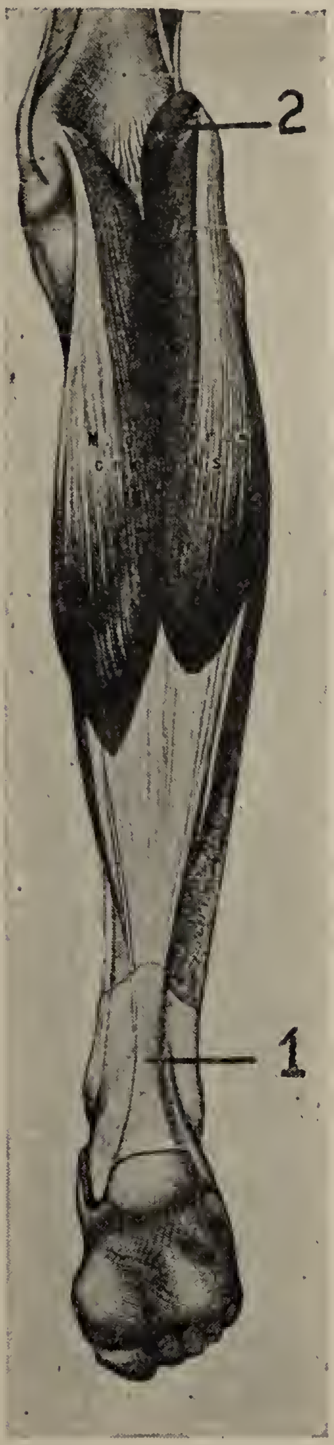

Figure 33—Superficial muscles of the posterior side of the lower leg. Heel-cord at 1. Upper limit of attachment of calf muscles at 2. After Toldt's Anatomical Atlas Republished by special permission of Rebman Company, New York

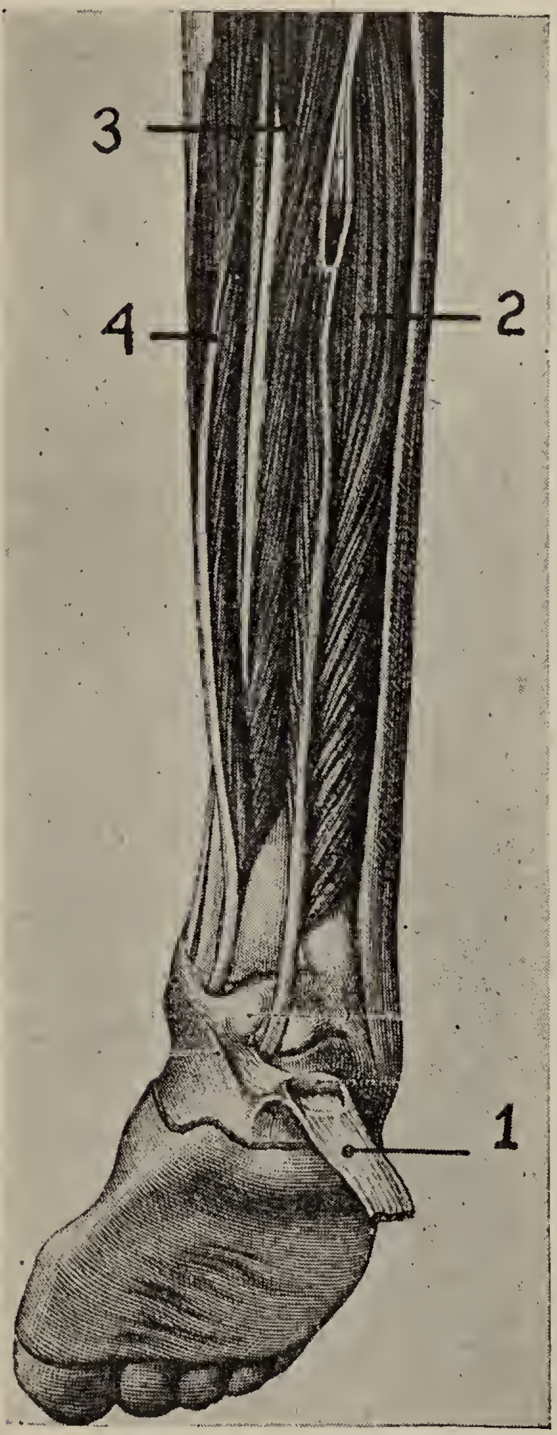

Figure 34—Deep muscles of posterior side of the lower leg. Heel cord turned down at 1. Muscle that flexes the great toe at 2. Muscle that flexes other toes at 4. Tibialis posticus muscle at 3. After Toldt's Anatomical Atlas Republished by special permission of Rebman Company, New York

bulk of muscle tissue required to support the entire weight of the body easily in walking, has to be placed from mechanical necessity in the lower leg where there is sufficient room for muscular activity and growth, and where there are extensive surfaces for secure attachments of muscle fibers. Six main groupings of muscles will be discussed briefly, but it should be understood that there are other combinations of muscle action, and that muscle balance is a very complex one in a normal foot.

1. Large muscles of the calf are collected into a single attachment on the posterior part of the heel bone by means of an extremely strong heel cord, or tendo Achilles. See the heel in Figure 33. This tendon pulls the heel upward when its muscles contract, and simultaneously the foot tilts as a whole at the ankle joint with a lever action so that the ball of the foot is depressed. If a person is standing, he is raised on tiptoe when this group of muscles shortens. Muscles contributing to pull of the heel cord extend upward on the posterior side of the leg above the knee, where the gastrocnemius muscle is fastened to the lower end of the upper leg bone. See Figure 33-2.

2. Toes are pressed strongly against the ground in walking, and it is not surprising that additional muscles are packed into the posterior side of the leg for purpose of flexing the toes downward. Flexor tendons of toes run down into the foot under bones at the inner side of the ankle, where they change their direction to pass forward through the sole to the toes. Figure 34-1 shows the heel cord cut and its heel attachment turned down. Its muscles have been removed entirely. Underlying muscles which flex toes are visible with their tendons disappearing in tunnels into the foot at the inner side of the ankle. Fig. 34-2, 3, 4.

As these curve around bones of the foot there are lateral pressures developed when muscles controlling these tendons are pulled tensely. Under these circumstances they help to hold up the long arch of the foot. The frontal arch is elevated also by strong contraction of long flexor muscles of toes. How these tendons continue through the sole to their terminations is shown in Figure 35-2, 3, 4. Notice that the great toe flexor is so important that it has a distinct tendon of its own. Fig. 35-2.

3. Muscles which pull up the inner side of the foot, helping to support the longitudinal arch, are shown in Figure 35 at (3) and (5). These are tibialis anticus and tibialis posticus tendons. The tibialis anticus muscle may be seen in Figure 36 at (5). Its tendon sheath enlargement at the ankle is represented in Figure 37 at (T).

The comparative directness of pull of the tibialis anticus tendon on the longitudinal arch makes this muscle often one of the first structures to exhibit signs of foot strain, and soreness is noticed in the leg where the muscle is situated rather than in the arch of the foot.

4. Peroneal muscles are placed on the outer side of the leg, and their tendons run down behind the outer side of the ankle to pull on the outer side of the foot. They tilt the foot as a whole at the ankle laterally in reverse direction from tibial muscles to which they are more or less opposed. The peroneus longus tendon turns under the foot bones into the sole and crosses diagonally to be fastened at the base of the great

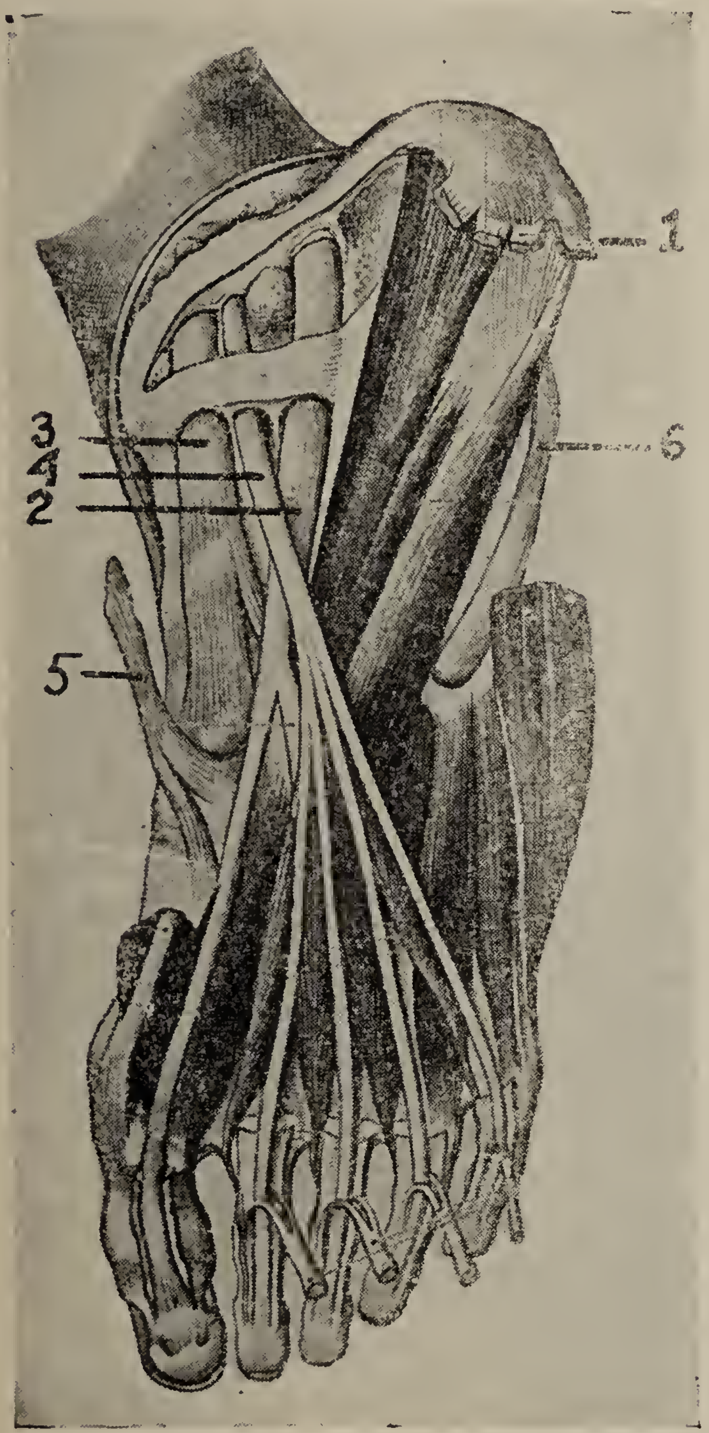

Figure 35—Under surface of foot showing continuations of tendons from leg muscles. Tendon that flexes the great toe at 2. Tendon that flexes other toes at 4. Tibialis posticus tendon at 3. Tibialis anticus tendon at 5. Peroneus longus tendon at 6. After Toldt's Anatomical Atlas Republished by special permission by Rebman Company, New York

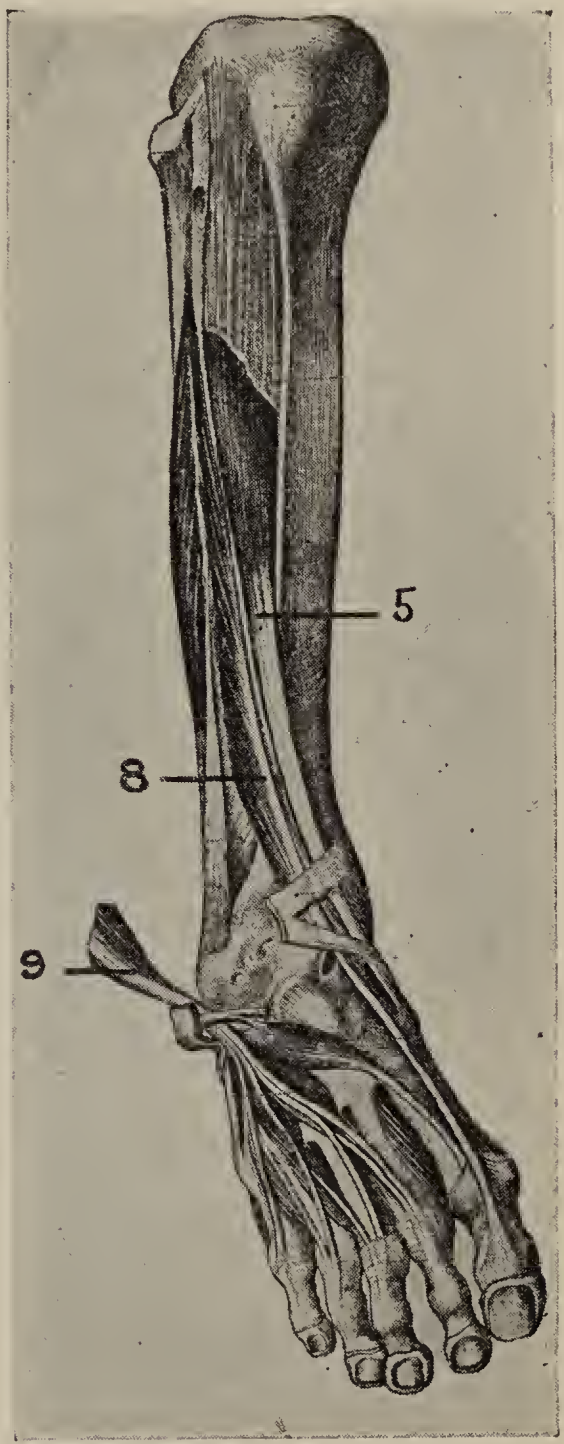

Figure 36—Muscles of the leg and foot—front view. Tibialis anticus tendon at 5. Extensor muscle of the great toe at 8. Extensor tendons of other toes at 9. After Toldt's Anatomical Atlas Republished by special permission of Rebman Company, New York

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toe. Figure 37-P shows peroneal tendon sheath enlargements at the outer side of the ankle, and Figure 35-6 shows the long peroneal tendon after it has turned into the sole to cross the latter diagonally.

5. Short muscles in the sole of the foot and their general arrangements are shown in Figure 35. They perform various functions and make possible some of the more delicate movements of the toes besides reinforcing long tendons. They fill in and bridge across the space between heel and ball, contributing to maintenance of arches of the foot to important degrees. The outer covering of fibrous tissue of these short muscles of the sole is unusually strong, and is called an aponeurosis. Figure 38 represents it stretching from heel to toes, and as muscles of the foot weaken beneath it, there are increasing strains

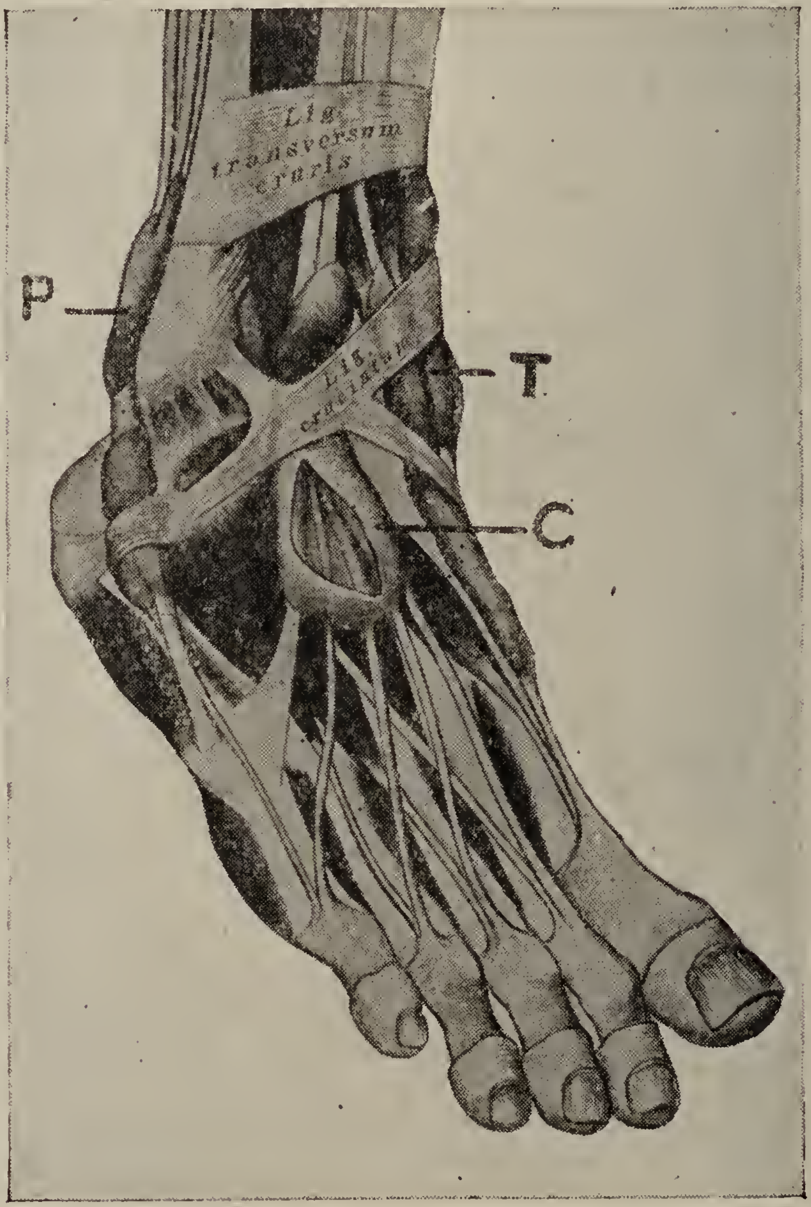

Figure 37—Tendons and tendon sheaths of the foot. Tibialis anticus tendon sheath at T. Peronel tendon sheath at P. Tendon sheath of extensor tendons of toes at C. After Toldt's Anatomical Atlas Republished by special permission of Rebman Company, New York

borne by this fibrous sheet. If it becomes strained to harmful degree there is likely to be soreness about its heel attachment as was explained in a previous chapter on policeman's heel. Short muscles of the sole, being under elastic tension, contribute elasticity to the step in walking.

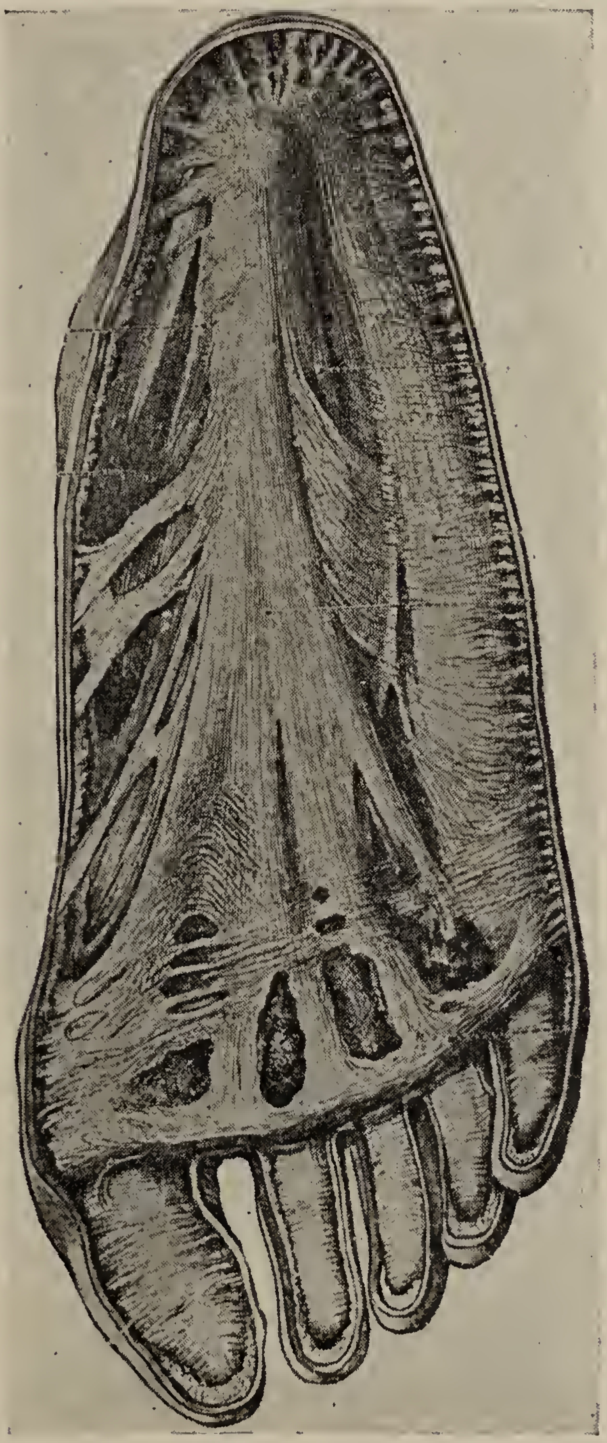

Figure 38—Fibrous covering of muscles of bottom of the foot extending from heel to toes. After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

6. Muscles on top of the foot are shown in Figures 36 and 37. There are long tendons running to toes from leg muscles, while shorter tendons run to toes from muscles attached to foot bones in front of the ankle and to its outer side. They are extensor tendons of the toes, and

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are opposed to the flexors on the under surface of the foot. They extend the toes or pull them up out of the way in walking so that toes are not stubbed too frequently while walking barefoot.

A normal muscle balance among various pulls exerted by various muscles has to be maintained to hold a foot in a normal posture. Otherwise there would be stretching of weaker ones by stronger ones, and deformities would appear, as in infantile paralysis, in which certain foot muscles lose their functions. Normal muscles exhibit congenital variations at times like all tissues of the body. Occasional slight variations in arrangements of foot muscles are observed. Variations in size and strength of individual muscles presumably occur at birth too, with resultant tendencies toward poor foot balance and foot deformity of muscular origin.

Let it be recalled that foot bones vary in size and in relative proportions to produce different foot shapes, broad or narrow, short or long. There is every reason to believe that foot muscles exhibit peculiarities of their own in similar manner although it is impossible to identify them easily.

A congenitally small weak muscle that is normal in other respects has marked powers of adaptability which all muscles possess. It can grow rapidly, and does so, until it strengthens sufficiently to meet tasks imposed on it by its larger associates. It draws on its reserve powers more extensively than the latter do in order to maintain a normal foot appearance with an even muscle balance.

There are latent weaknesses in such feet which show quickly when feet are subjected to unusual strains; and very probably some individuals who have chronically weak feet have also unrecognizable congenital muscular defects underlying their troubles. The latter cannot be diagnosed positively because reserve powers of muscles cannot be measured. Such explanations at least appear most plausible for extremely relaxed, deformed and poorly balanced feet which some unfortunate persons possess.

CHAPTER XIII

MUSCLES THAT MOVE THE FEET—Continued

Microscopic anatomy of muscles appears to be removed a long distance from shoe salesmanship. Yet shoes that are fitted by salesmen may influence microscopic units of muscles either favorably or unfavorably. The satisfaction or dissatisfaction of a customer depends in part on effects produced by shoes on microscopic muscle fibers. Furthermore microscopic anatomy of muscles must be understood for best comprehension of the details of muscle physiology that are described in the next chapter. Both of these topics have to be familiarized for most perfect understanding of uses and limitations of various types of shoes and of foot appliances.

Second Installment—Minute Structure of Muscles

What do muscle fibers look like under a microscope? How are they bundled together, attached to bone, protected from harmful influences, and supplied with materials for growth?

Clear ideas of structure of microscopic units permit clearer understandings of actions of large muscle masses; and the following explanations are essential for comprehension of muscle physiology as dealt with in the next section. Shoe fitters will continue to make same errors of judgment until they learn more about muscles.

Figure 39 is a drawing of human muscle fibers greatly enlarged. Fibers are represented as parallel cords packed closely together, and there are shown in this illustration two layers of inelastic connective tissue which partition off bundles of muscle filaments. Cross markings are seen in muscle tissue that are not present in the two fibrous partitions. Small dark spots called nuclei are distributed irregularly throughout the picture, and they are important structures which need not be explained, however, in the present discussion.

Each muscle fiber is enveloped by a membrane of inconceivable thinness, and within this limiting membrane is contained the tender contractile muscle substance. Cross markings are produced by peculiarities within the contractile mass, and give the name of striated muscle to such fibers.

Figure 40 represents three muscle fibers enlarged still more, and prepared by a special microscopical method to show the way that extremely fine nerve branches of motor nerves break up into "end plates" on surfaces of muscle fibers. In end plates nervous impulses are able, in obscure, unknown ways, to stimulate muscle tissue to contract.

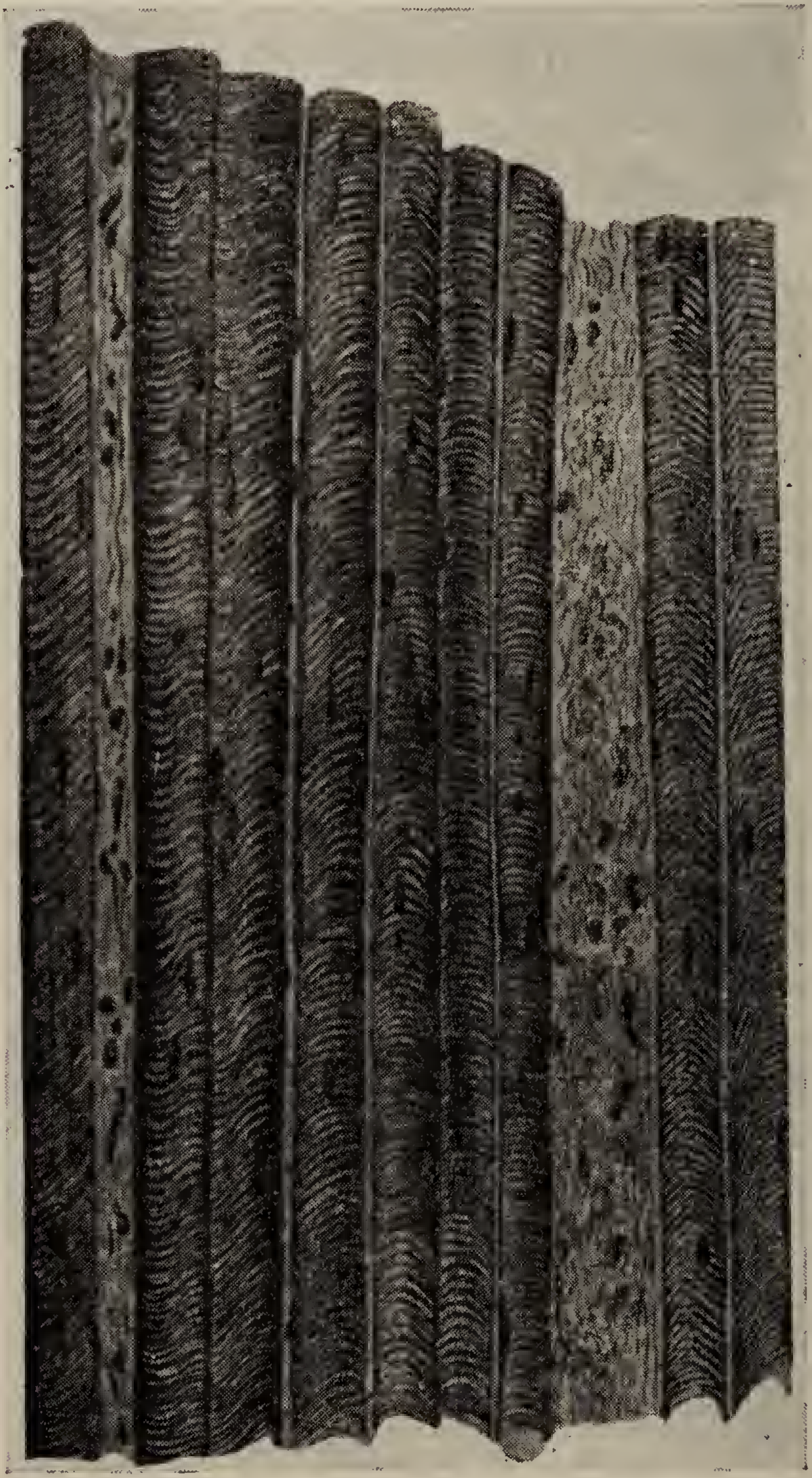

Figure 39—Human muscle fibers as seen greatly enlarged through a microscope—After Toldt's Anatomical Atlas, Republished by special permission of Rebman Company, New York

Thin-walled capillaries and nerve filaments have not been represented in figure 39, because collapsed capillary walls would appear to be fine lines, which would be distinguishable with difficulty among connective tissue fibers. For the same reason nerve filaments are not mentioned. Capillaries, however, run between muscle fibers, and substances soak through their walls from the blood stream into spaces between them and limiting muscle membranes. Actual spaces do not exist when capillary walls lie in contact evenly with membranes, but there are always some irregular clefts between the two surfaces somewhere, which are filled with fluid. Substances also soak out from the interior of muscle fibers into these clefts which are called *lymph spaces.* Fluid filling lymph spaces is called *lymph.* Lymph contains some useful and some useless substances. It is a combined food supply and sewer for the tissues.

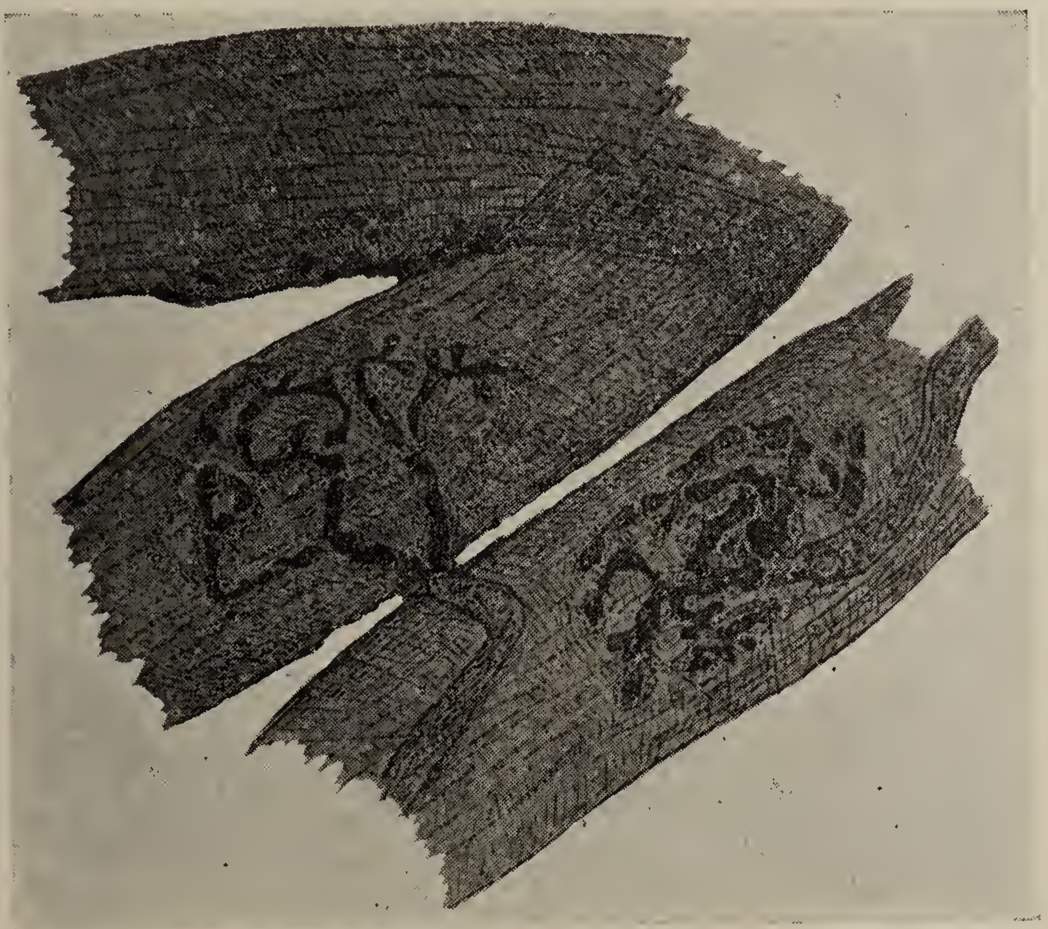

Figure 40—Human muscle fibres very greatly enlarged, and showing endings of nerves on surfaces of the fibers.—After Toldt's Anatomical Atlas, Republished by special permission of Rebman Company, New York

Lymph spaces are continuous with others in irregular manner, and lymph oozes slowly through muscles until it reaches lymph spaces which appear to have delicate walls. The latter collect into definite lymphatic vessels that conduct lymph away and return it, after filtering through special lymph nodes, into large veins for further purification and re-distribution in general circulation.

Very delicate connective tissue fibers run sparingly with capillaries and with nerve fibers among muscle filaments. Small groups of muscle fibers are united into small bundles by thin inelastic connective tissue coverings. Larger muscle bundles are bound together by stronger fibrous coverings, and an entire muscle is enveloped in a continuous strong inelastic fibrous sheath of like nature.

Larger blood vessels and nerves make their way through larger connective tissue partitions, or septa as they are called, and distribute their branches to smaller septa from which ultimate distribution in the tissue is accomplished by further branching.

Figure 41 is a cross section of a human muscle, and its actual appearance might be indistinguishable from cuts of meat in any butcher's shop. Anyone who has eaten lean meat knows roughly what muscle fibers are like, because meat is composed largely of these contractile masses. It is needless to state perhaps that tough meat has well developed fibrous connective tissue partitions, and that tender juicy properties of meat depend on the contractile muscle pulp.

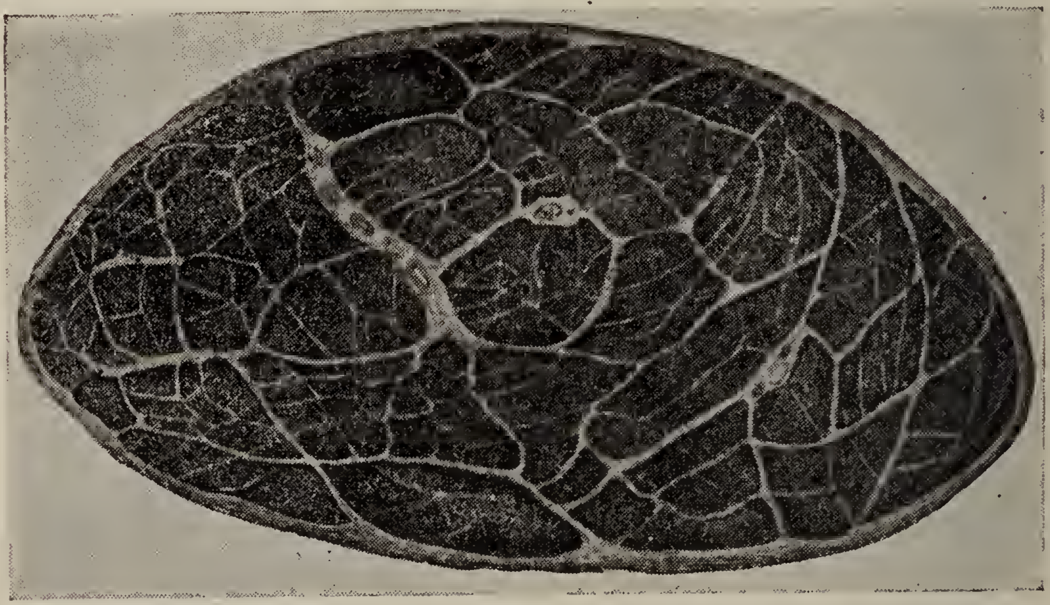

Figure 41—Cross section of a human muscle showing masses of muscle fibers and partitions of connective tissues, with blood vessels in the thickest partitions.—After Toldt's Anatomical Atlas, Republished by special permission of Rebman Company, New York

Figure 42 is a useful schematic drawing of a muscle and its attachments. Fibrous partitions are represented as converging into a common fibrous prolongation, the muscle tendon, at one end. At the other extremity they are attached by fine filaments to a large bony surface, securely and evenly, without uniting into a single cord. The tendon is represented as attached to a smaller area on another bone by similar fine fibers. A small protective bursa is shown at the juncture of tendon and bone. The use of this small, closed sac, is for protection of the tendon from rigid underlying bone, when outside pressures jam the tendon against the bone. Muscle fibers in the drawing are represented purely schematically, as parallel striated columns between connective tissue septa.

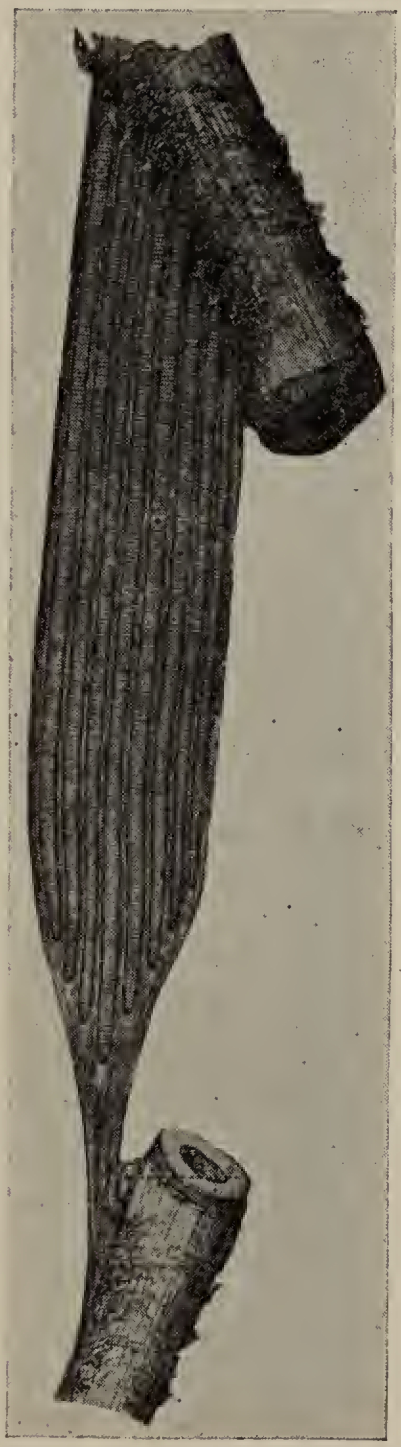

Figure 42—Diagram of a muscle and its attachments. — After Toldt's Anatomical Atlas, Republished by special permission of Rebman Company, New York

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CHAPTER XIV

MUSCLES THAT MOVE THE FEET—Concluded

MUSCLES THAT MOVE THE FEET ARE SUBJECTED TO VARIOUS INFLUENCES THAT AFFECT CONTINUANCE OF THEIR NORMAL FUNCTIONING; AND ALL SUCH INFLUENCES HAVE BEEN COLLECTED IN FOUR MAIN GROUPS DESCRIBED BELOW. MUSCLES REACT TO INFLUENCES IN WAYS THAT ARE PECULIAR TO MUSCLE TISSUE. KNOWLEDGE OF MUSCLE REACTIONS AND OF FACTORS THAT ENTER INTO MAINTENANCE OF NORMAL MUSCLE FUNCTIONS MAY MEAN MORE SKILLFUL SHOE FITTING IF SIMPLE PRINCIPLES OF PHYSIOLOGY ARE APPLIED PROPERLY TO THE SHOES AND FEET OF CUSTOMERS.

Third Installment—Muscle Physiology

Muscle physiology for shoe men may seem to be a new departure. They have learned of bony peculiarities and have studied effects of shoes on shapes of feet. Physiological principles, which make flexible or stiff shoes successful or unsuccessful, are less generally known, and, since shoe fitters must continue to fit shoes that influence foot muscles, they should understand principles of muscle physiology as thoroughly as they do the anatomical structure of feet.

Let the reader keep in mind a picture of microscopical appearances of single contractile muscle fibers which are bathed in lymph, surrounded by capillaries, supplied with nerve filaments, and bound into bundles by fibrous connective tissue envelopes as described in the previous chapter.

There are four main channels only through which contractile muscle fibers may be influenced, and to which they respond by shortening or lengthening slowly or rapidly, strongly or weakly, completely or incompletely, temporarily or continuously. A muscle may be influenced through nerve filaments which end in its contractile fibers; secondly, by blood which flows through it; thirdly, by repeated mechanical strains that it is designed naturally to resist or to produce itself; fourthly, by various external factors—such as electricity, heat or cold, light rays, mechanical pressures or injuries. Each of these four main channels will be discussed individually.

(1) NERVOUS CONTROL OF MUSCLE. There are groups of nerve cells in the spinal cord which control voluntary muscles by sending out nervous impulses through motor nerves to them. Motor nerves start in the spinal cord and terminate in end plates on surfaces of muscle fibers.

If a motor nerve running to a normally relaxed muscle is severed so that nervous impulses cannot reach its muscle fibers, then the muscle will relax still more, although it was relaxed to a usual limit previously. This experiment shows that a motor nerve exerts a slight unrecognizable influence continuously on contractile muscle substance under normal conditions, holding it under slight tension, ready for instantaneous voluntary shortening.

This permanent slight tension is called *muscle tone*, and it varies from time to time with variations in action of controlling nerve cells. Muscle tone may be increased by administration of certain drugs which stimulate spinal nerve centers to increased activity. Tone is lost in diseases like infantile paralysis that destroy spinal nerve cells. Muscles controlled by destroyed cells in consequence become paralyzed.

If a muscle is worked hard until it will contract no more, because of fatigue of its controlling nerve cells, it will contract further, however, in response to direct stimulation of its muscle fibers. Such an arrangement prevents nervous stimuli from becoming harmful, which might happen if nerve cells were capable of tiring their muscles completely before they became fatigued themselves.

Ordinary muscular contractions are temporary, rapid shortenings of muscles of very marked degree typically, and they are usually performed as voluntary acts in contrast to involuntary slight continuous elastic tension developed by muscle tone. Repeated voluntary contractions soon cause fatigue, whereas there is no fatigue realized from normal muscular tone.

(2) EFFECTS OF CIRCULATING BLOOD ON MUSCLES. Tiny rivulets of blood from the general blood stream trickle past muscle fibers through capillary networks, and produce effects with variable degrees of slowness on tender contractile muscle tissue, depending on qualities and quantities of blood which pass.

A useful comparison can be made between the system of large veins which collects blood from various parts of the body, and a broad, swiftly-flowing river, which is receiving continual contributions from its many tributaries.

A heavy local rainfall may swell the volume of some important river branch, so that its turbid waters, rushing into the general current, modify the character of the latter, temporarily, to an important degree. Perhaps another branch is being polluted continually by sewage from a city, or there may be a large industrial plant that is poisoning the water with chemical wastes on another stream to the extent that fishes have difficulty in surviving in the river.

There is mingling of waters from various tributaries in the broad main current. There is perfect mixing of blood from all veins by the time the main blood stream issues from the heart to be distributed to all body tissues.

Important tributaries from the digestive tract may bring into general circulation, temporarily, a swollen, turbid stream, figuratively speaking, if the person has eaten too heartily and if digestive processes have been upset temporarily. Perhaps another tributary is being polluted continually by an important city of bacteria, located on its banks. Or there may be poisoning of the blood stream by alcohol or by harmful drugs which gain admittance to the circulation, so that blood corpuscles living in it have as hard a time as fishes in a river that has been poisoned by industrial chemical wastes.

Contributions to the main blood stream from all organs are of amazing variety and much has to be learned yet regarding many of them. It is not necessary, though, to attempt to describe exact mixtures and proportions among blood constituents that are most favorable, or unfavorable, for the welfare of foot muscles.

It is sufficient in the present connection to understand clearly that shifting qualities of blood exist from time to time; and that some combinations cause muscles to weaken or relax, while other combinations produce different effects.

The element of time has to be kept in mind. A mildly harmful influence, or a beneficial one has its effect multiplied by the length of time of its action, also its effect is influenced by its continuous or intermittent nature.

Blood may be considered the soil on which muscle fibers grow in comparison with agricultural crops growing in the ground. A barren soil will not produce good crops, and some soils are too acid for best development of certain types of vegetation. Similar conditions exist apparently in the soil on which muscle fibers thrive. If blood is rich, containing all necessary constituents in good proportions and no harmful ones, or no excessive amounts of useless constituents, then muscles will grow larger and stronger than they will on poor soil.

Poor soils may produce defective rheumatic muscles or stunted weak plants. Internal integrity of contractile muscle substance deteriorates apparently if it is subjected to poor blood continuously, although perhaps its outward appearance may show little change. Muscle contractions become feeble, slower, and less extensive in old age as internal muscular vitality slowly ebbs. Similar changes may appear earlier if blood during life has been poor much of the time.

Muscles have an advantage over agricultural crops in that circulating shifting soil may be modified to suit needs of muscles more easily than crops can be transplanted into new ground.

Finally, in connection with effects produced by circulating blood on muscles, mention has to be made of difficulties that exist in telling whether blood is acting directly and solely on contractile muscle substance, or whether it influences muscles indirectly by modifying the activities of motor nerve cells which also control muscles. For the same blood mixture is delivered from heart to nerve cells through other capillaries. These two possible ways of influencing muscle fibres always exist, and presumably one is more important than the other at certain times, while a reverse state of affairs is true in other instances; or both channels of influence may be of equal importance.

(3) EFFECTS OF MECHANICAL STRAINS ON MUSCLES. If a muscle is not used, its contractile fibers gradually shrink in size and become weakened. Muscle shrinkage becomes extreme and permanent at times in progressive types of chronic joint troubles, and in worst instances there may be little more than the connective tissue coverings of elastic muscle fibers left.

When a muscle increases in size and strength, there is increase of size in each fiber, the total increase in volume of an entire muscle roughly indicating, perhaps, the average increase in size of individual fibers.

Moderate amounts of voluntary muscular exercise keep muscles strong, which means that repeated mechanical strains are beneficial as they occur in ordinary bodily activities.

Excessive amounts of voluntary exercise or excessive single strains produce temporary harmful reactions or over-strains. Over-strained muscles are very slow in recovering their usual strength, times of recovery depending on degrees of over-strain.

Alternating periods of voluntary activity and rest are essential for continued average muscle function; and varying proportions between the two are required by different persons in maintaining the same degree of strength apparently.

Maximum and minimum limits of strength exist for every muscle. Maximum limits depend on degrees of congenital muscular development, plus changes that take place during life subsequently. Small, weak muscles may be increased very gradually to average strength or better, after a long series of years of continuous favorable conditions probably. Large, strong muscles can be decreased in strength gradually and permanently, probably after a long series of years of abuse. Size is not an absolutely accurate measure of muscle strength and endurance, for some large muscles do not seem to be as strong as smaller muscles of other individuals. Presumably much depends on the quality of the contractile muscle substance. The minimum limit of strength of all muscles is zero.

Connective tissue septa and sheaths of muscles are important. They serve as checks to excessive stretching. Otherwise, a contractile muscle mass without any covering might act like a bundle of pure gutta percha filaments that elongate under increasing strains to enormous lengths. If muscles were permitted to stretch as much as contractile muscle tissue would permit, conceivably there might be injuries to bones and ligaments from over-strain in unusual postures. In the foot the fibrous sheet that stretches from heel to toes, covering muscles of the sole, helps to prevent acute strain of the arch when muscles temporarily become too fatigued or weakened. When a muscle ruptures in an injury the fibrous parts give way first.

(4) VARIOUS EXTERNAL INFLUENCES ACTING ON MUSCLES. Shoes are included among external influences, but they will be considered in a following chapter. Adhesive straps applied to the skin over courses of strained muscles afford an external mechanical means of partly relieving continuous harmful strains. Light rays from the sun or from electric lamps are external influences, which may relieve stiffness of muscles by penetrating into their depths where they are transformed into heat. Different colors of light rays apparently produce different effects. Heat makes muscles react more readily and completely. Cold has the reverse action of slowing and lessening muscular activity, as everyone knows who has been chilled and numbed by exposure to cold weather. Alternating hot and cold treatments are used with benefit in some instances in restoring normal muscle function. Massage accelerates the flow of lymph after exercise and is an external means of influ-

encing muscles favorably. Electric currents are used to make muscles contract at regular intervals by direct stimulation of muscle fibers, when nerves have been injured so that normal nervous stimuli cannot reach muscles. Under these circumstances external applications of electricity may retard harmful muscular shrinking for a while.

Combinations of external agents are used in hot baths and local massage. The heat dilates arteries locally and floods capillaries. There may be direct action on muscles if heat is prolonged at high enough temperature. Massage affects muscle fibers mechanically. Massage also accelerates removal of lymph, permitting its rapid replacement by fresh fluids from dilated capillaries. Lymph becomes less of a sewer and more of a food supply, and in consequence it assists in rapid restoration of fatigued muscles; although there is less virtue in replacement of lymph, if blood is of irritating quality.

PHYSIOLOGICAL ACTION VERSUS PHYSIOLOGICAL REACTION. It is possible on the one hand to describe all physiological influences acting on muscles; or, on the other hand, to describe physiological reactions to all external influences of the contractile muscle substance within muscle fibers. Both methods deal with the same sets of facts.

Either the four main channels of physiological action that have been mentioned may be explained, or the same facts may be introduced under headings that relate to internal reactions of muscles; namely, muscular vitality, adaptability, contractility, strength, endurance, and size.

If the latter presentation were used then there would be special discussion of maximum and minimum limits of muscular vitality, adaptability, contractility, strength, endurance, and size; also ways by which each limit may be varied favorably or unfavorably.

Attention would be called to the continuous combined variable influences that muscles are subjected to *always* through blood, nerves, and external agencies; as well as the influence of usual mechanical strains of normal activity much of the time.

Shoe fitters who are familiar in a general way with muscle reactions and the main channels through which muscles are acted on, perhaps will understand customers' peculiarities better, and appreciate better the possibilities and limitations of footwear and of medical care.

CHAPTER XV

LIGAMENTS, JOINTS, BONES

ANATOMICAL PICTURES ARE MORE EASILY UNDERSTOOD THAN ANATOMICAL DESCRIPTIONS AND IN THIS SECTION THE AIM IS TO GIVE READERS ACCURATE GENERAL IMPRESSIONS OF NUMBERS AND LOCATIONS OF LIGAMENTS, JOINTS AND BONES WITH A MINIMUM AMOUNT OF MEDICAL NOMENCLATURE. SIGNIFICANCE OF BONY VARIATIONS MAY BE GREAT AT TIMES, BUT BONY FOOT STRUCTURES HAVE BEEN STUDIED MOST THOROUGHLY AND ARE MOST FAMILIAR TO READERS PRESUMABLY, AND THEREFORE PERHAPS DISCUSSIONS OF BONY VARIATIONS CAN BE SAFELY OMITTED IN THE PRESENT CONNECTION.

Bones make feet long and slender, or short and broad, or of intermediate types, as experienced shoe fitters know better in a general way than most persons do. Bones have been studied so exhaustively that there is little need in the present connection of reviewing familiar facts about them. Normal arrangements of foot bones are indicated sufficiently well in the illustrations used for ligaments and joints.

Diseases of bones and joints should be discussed for completeness, but such matters are of less practical interest to shoe men than points which relate to normal shapes and functions of feet, and therefore bone diseases will be omitted.

Ligaments are flexible, strong, inelastic, fibrous structures, and they bind all foot bones into a single mass. They permit limited changes of positions among bones while simultaneously they prevent abnormal bony displacements. Values of joint motions even of slight degrees can be appreciated best when joints become rigid and sore or rigid and painless. Feet would be far less efficient if they consisted of single rigid masses. Some indications of numbers, locations, and peculiarities of joint surfaces can be obtained from the cuts.

Increasing strains are put on ligaments as muscles relax, and if muscular weakness or stretching becomes sufficiently great or is prolonged, there may be weakening and stretching of ligaments very slowly. In mild cases of foot strain presumably ligaments retain their

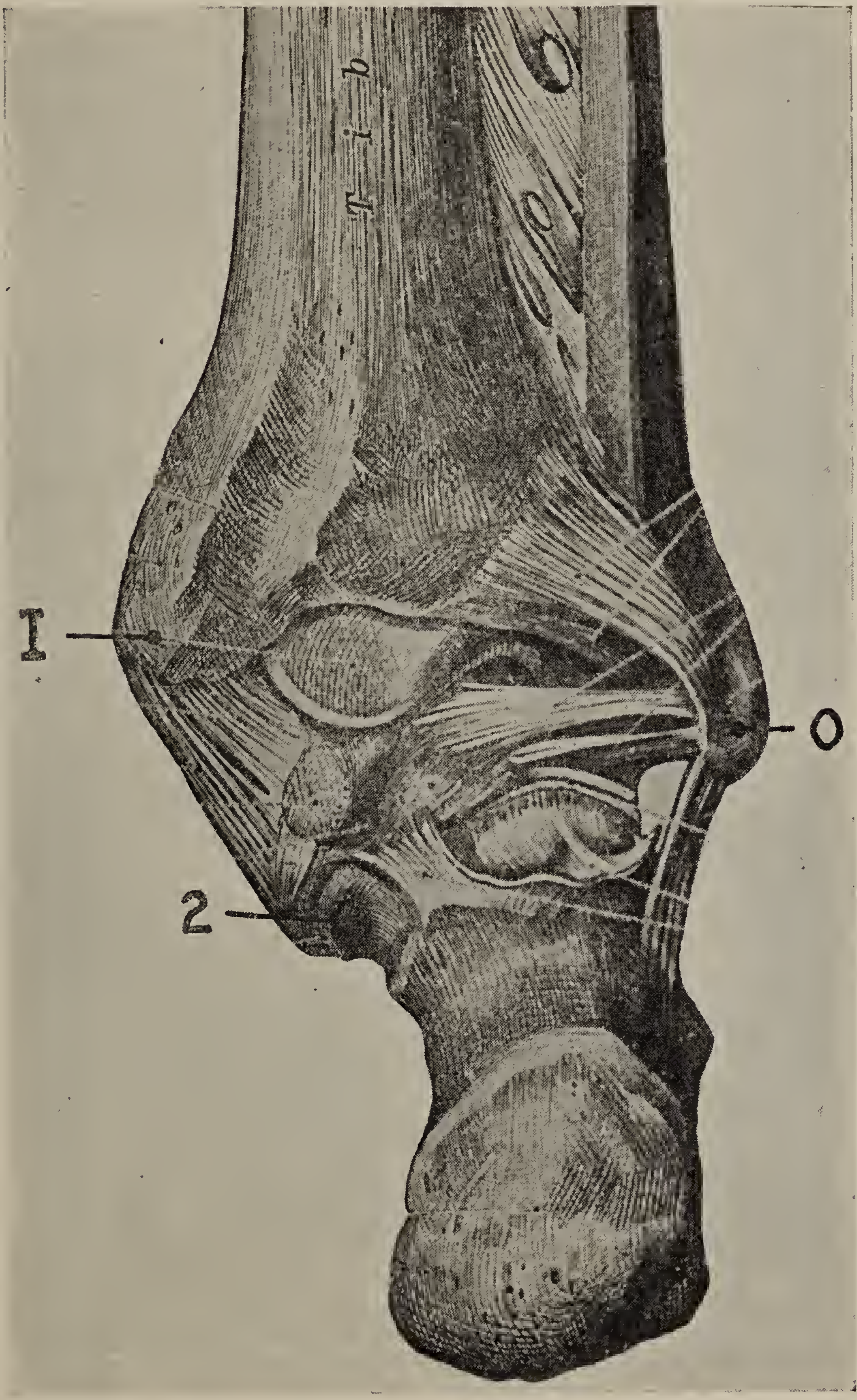

Figure 43—View of bones and ligaments from behind the ankle, showing heel bone below, a groove for the flexor tendon of the great toe at 2, and various ligaments about the inner side of the ankle and foot at 1. The outer prominence of the ankle is at 0.—After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

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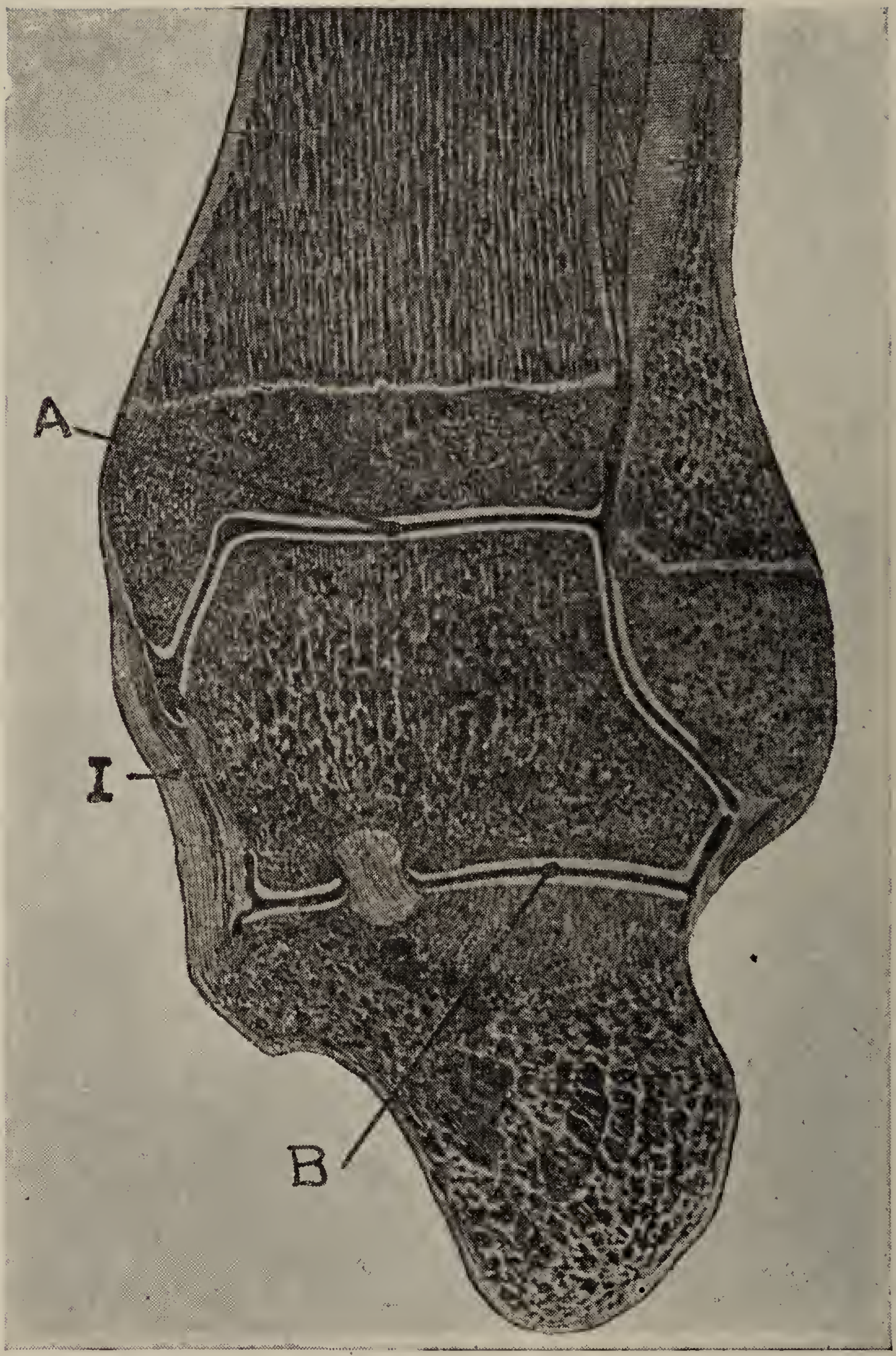

Figure 44—A sectional view through the ankle joint. Compare with figure 43. Ligaments at the inner side of the foot are shown at 1. The ankle joint is represented at A, and its cartilaginous lining is indicated by the white lines. Notice how the outer bone of the lower leg extends down at its outer side, while the inner bone of the lower leg projects downward at the inner side of the joint. The astragalus is the bone which is wedged in between these two leg bones to form the ankle joint. Below the ankle joint, between the astragalus and the heel bone, is another joint shown at B.—After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

normal integrity, and muscles alone are involved to an appreciable extent.

Physiological peculiarities of ligaments are recognizable in their variable strengths from time to time. They strengthen or weaken, as far as can be told, with use or disuse respectively, as muscles or bones do under similar circumstances. They will deteriorate very slowly under continued unfavorable circulatory conditions in a manner comparable to ways that muscles deteriorate. Ligaments are able to repair themselves after injuries like all living tissues, and in time they may contract slowly to take up laxities that previously developed. Some ligaments of the spine appear to be under continuous tension similarly as muscles are held normally under slight continuous tension.

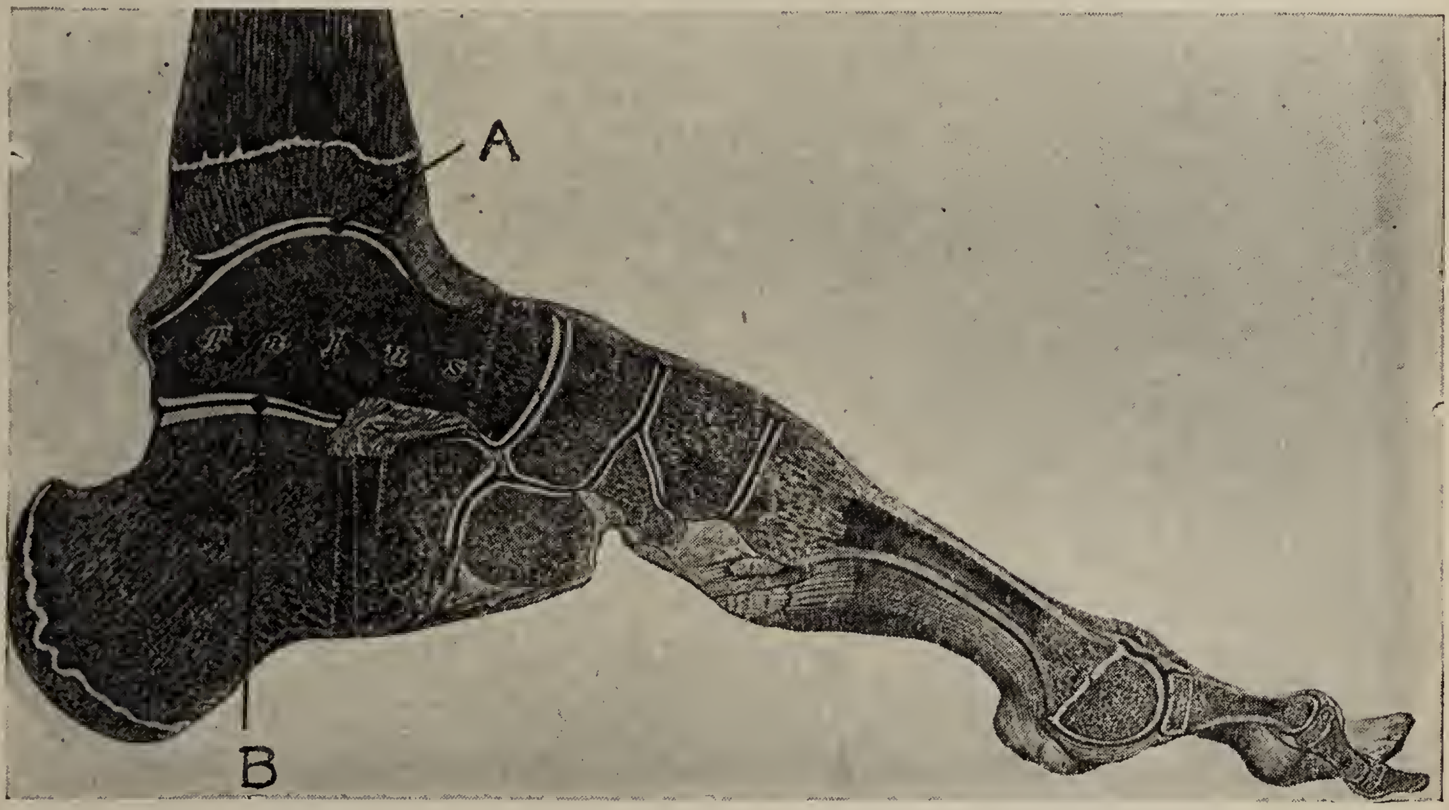

Figure 45—A sectional view longitudinally through the foot, showing the ankle joint at A, and the joint between the astragalus and heel bone at B. Other small joints are indicated by other similar white lines.—After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

Strengths of ligaments may be restored completely apparently at times, but with laxities persisting, as in certain types of symptomless flat feet. Certain ligaments are extremely strong, thick, inelastic bands, and these will tear loose from their bony attachments or pull off small bits of bone instead of tearing across through masses of strong fibers. Other ligaments are thinner expansions that may begin to pull apart evenly without actual open rupture, and thus become relaxed and stretched.

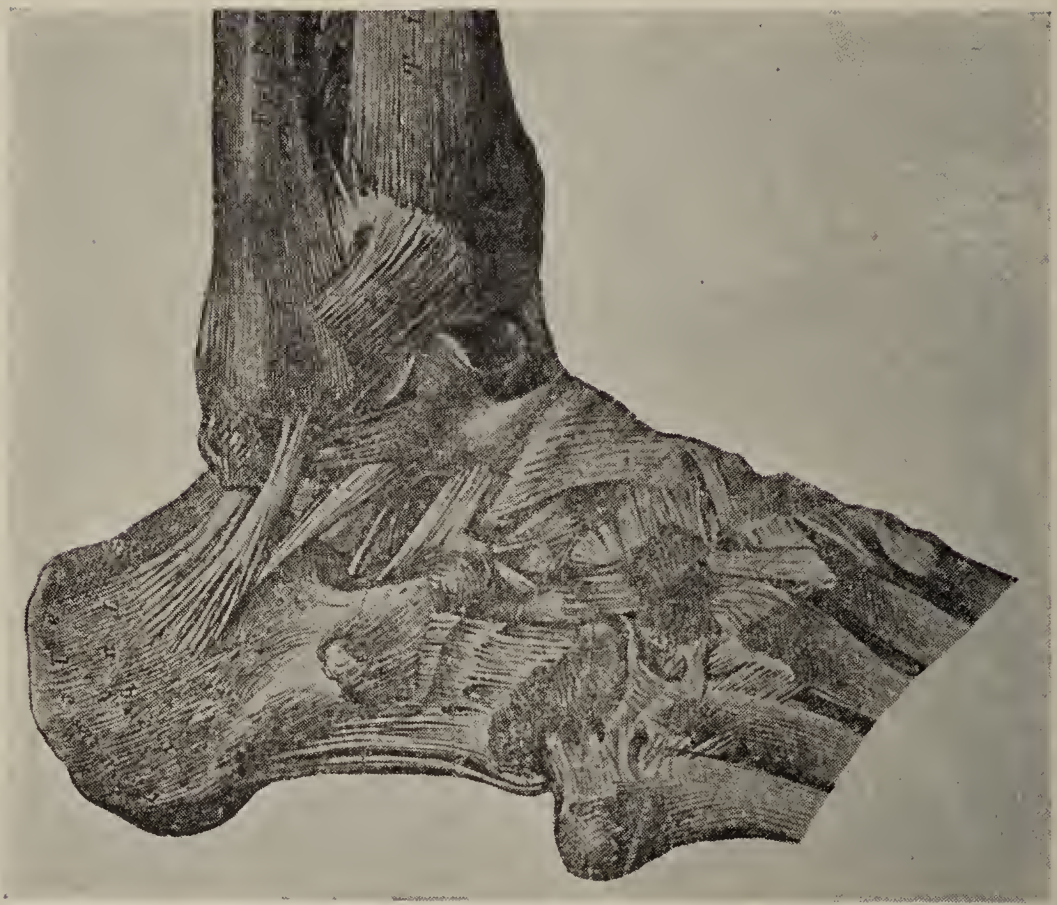

Figure 46—Lateral view of foot and ankle, showing numerous small ligaments which bind small bones together, also the heel bone to lower end of outer bone of the leg, namely, the fibula.—After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

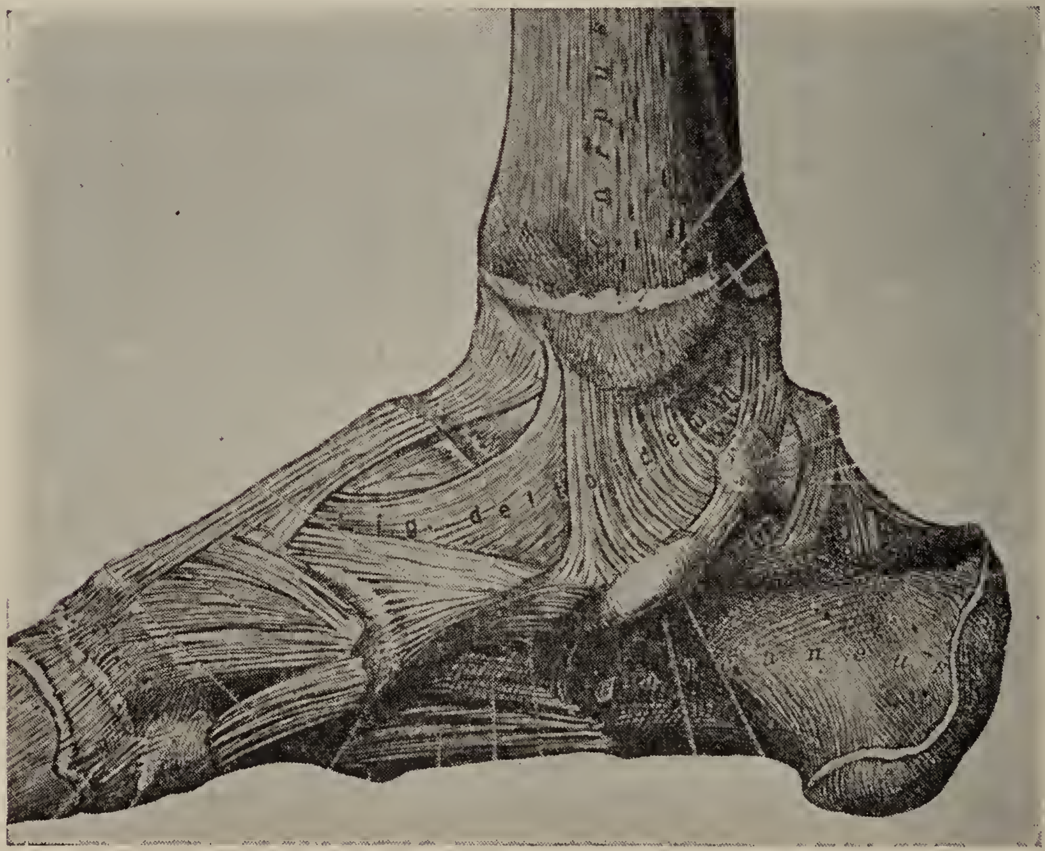

Figure 47—Lateral view of foot and ankle, showing strong ligaments at the inner side of the foot, and the heel bone attached to the lower end of the inner bone of the leg, the tibia.—After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

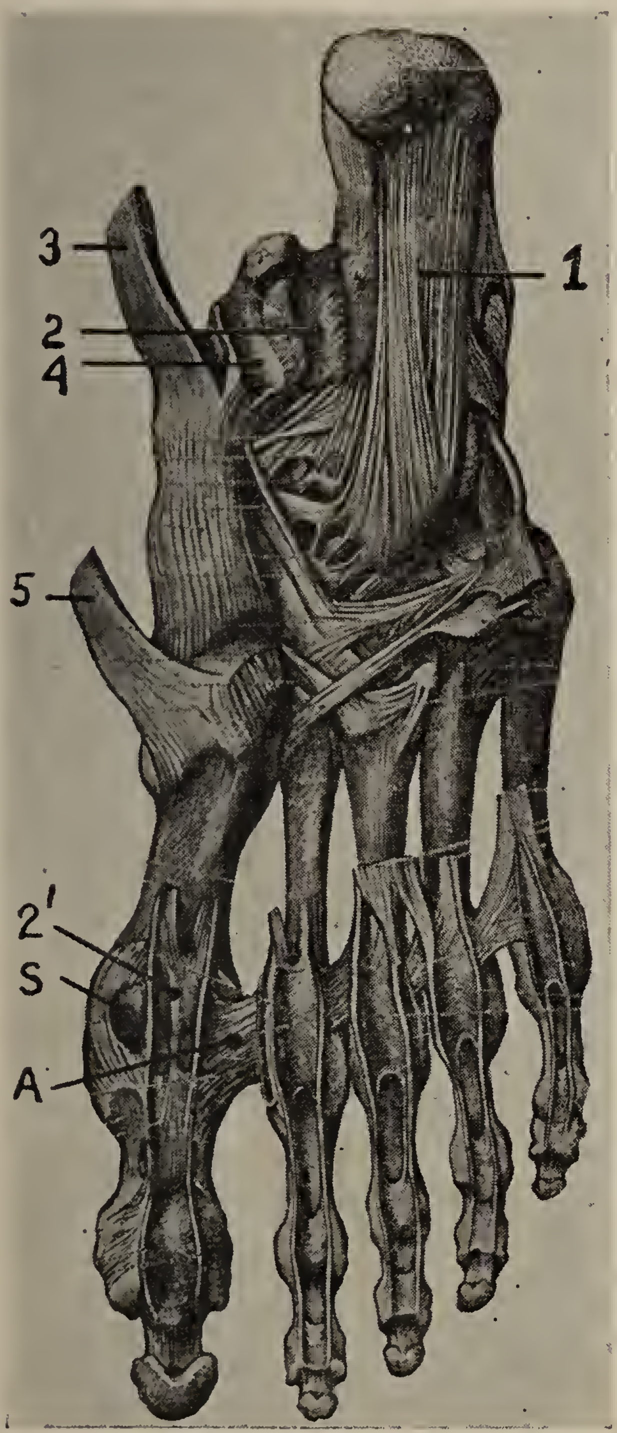

Figure 48—View of bones and ligaments on the bottom of the foot. The strong plantar ligament at 1. The fibrous tendon sheath at 2. Fibres of the anterior transverse ligament at A. A sesamoid bone at S. Bony grooves for the flexor tendon of the great toe and other toes at 2 and 4 respectively. Tendons of the tibialis anticus muscle and tibialis posticus muscle at 5 and 3 respectively.—After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

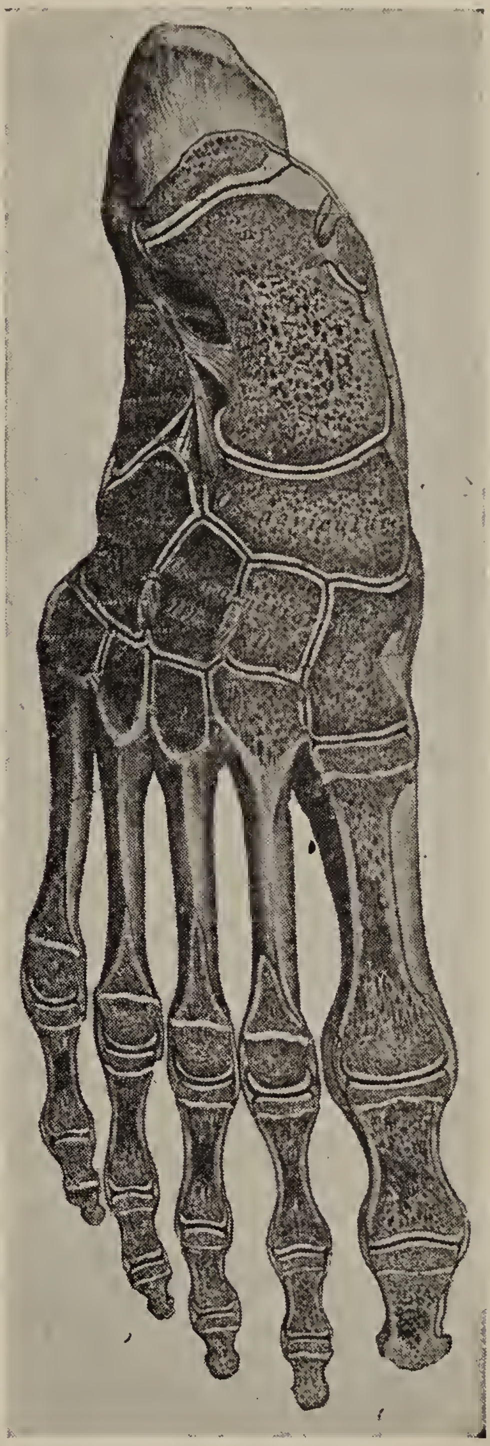

Figure 49—A sectional view of the foot as seen from above, showing the distribution of joint surfaces among the small bones.—After Toldt's Anatomical Atlas. Republished by special permission of Rebman Company, New York

Studious readers are advised to get, if possible, the large new American edition of Toldt's *Atlas* that has been published by the Rebman Company of New York. In it are given names of the different structures that are purposely omitted from illustrations here. In the present connection the aim must be to give shoe men accurate general impressions with minimum amount of reading, and perhaps stimulate some to search for further knowledge from reliable original sources.

CHAPTER XVI

FLEXIBLE SHOES, STIFF SHOES, ARCH SUPPORTS

PRACTICAL OBSERVATIONS ON THE USE OF EACH TYPE OF SHOES AND OF SUPPORTS HAVE BEEN MADE IN SUFFICIENT NUMBERS; YET CONTROVERSIES AND ANTAGONISTIC VIEW POINTS SEEM PERHAPS TO INCREASE RATHER THAN TO DIMINISH IN NUMBERS. IT IS TIME THAT ATTENTION SHOULD BE SHIFTED FOR AWHILE FROM SHOES AND SUPPORTS THAT OF THEMSELVES MAY BE ALL RIGHT, TO UNDERSTANDINGS OF PERSONS WHO FIT SHOES AND SUPPORTS. WHEN PHYSIOLOGICAL PRINCIPLES AS WELL AS ANATOMIC PECULIARITIES CONTROLLING FOOT CONDITIONS ARE BETTER UNDERSTOOD GENERALLY, THERE MAY BE SUBSIDENCE OF MANY USELESS CONTROVERSIES NOW EXISTING.

Effects of differing grades of flexibility or stiffness in shoes and supports will constitute chief topics for discussion in this chapter, while matters concerning proper shoe shapes or shoe sizes will be disregarded entirely.

There have to be considered shoes of extreme or moderate flexibility as well as moderately or extremely stiff shoes. An extremely flexible type possesses extremely slight stiffness; a moderately flexible type has considerable stiffness; a moderately stiff type has considerable flexibility, and an extremely stiff type has extremely slight flexibility.

It is well to remember that most shoes and many arch supports have such stiff and flexible features simultaneously, although a few types have flexibility reduced to zero. Any of these varieties of shoes or supports may be used properly or improperly.

Persons wearing flexible shoes with perfect satisfaction to themselves are able to do so because their muscles are well developed and strong enough, because blood is good enough, because nervous factors influencing feet are normal enough, and because external influences acting on feet are satisfactory enough.

Feet in flexible shoes will break down if nervous-vascular influences become unfavorable enough. Nervous and vascular influences are mentioned together because both are acting always and because it is difficult to separate the two accurately. Feet will break down if increased excessive muscular work or external injuries of sufficient severity enter into the situation. They may become weakened first through unfavorable nervous-vascular conditions, and the actual breakdown be precipitated by injuries, or excessive exertions, or unfavorable shoe changes of comparatively slight degrees. They may be weakened first by influences just mentioned as causing final breakdowns, and with nervous-vascular factors determining actual upsets in normal conditions.

Feet fitted perfectly with flexible shoes will break down whenever the sum of combined influences acting on them becomes sufficiently bad. At times one cause may be more pronounced than others of the acting combination. In some instances different elements of the combination appear to be about equal and nearly all slightly unfavorable. Usually there are some favorable and some unfavorable factors among the entire number of influences affecting feet; and whenever this balance between favorable and unfavorable elements becomes too bad, then abnormal symptoms make their appearance.

Persons wearing stiff shoes with perfect satisfaction to themselves are able to do so for precisely the same reasons that have been given for flexible shoes. The long list of comprehensive statements just made relating to flexible shoes may be repeated word for word, as applying to stiff types of footwear, by simply substituting the term "stiff" wherever "flexible" has been employed. What then, are the important differences between flexible and stiff shoes?

Flexible shoes exercise muscles more than stiff ones do, while stiff shoes protect feet more than do flexible ones. Foot muscles must do more work themselves in flexible footwear than in stiff shoes, while performing similar tasks. Adaptable muscles in consequence increase in strength in flexible shoes to meet extra demands made on them.

How much stronger will feet become in flexible shoes? As much stronger as is necessary to compensate for loss of support previously enjoyed in stiff shoes. When a change is made in shoes there is a feeling of increased security and comfort if stiff ones are put on; whereas, soon there is an increased feeling of freedom and strength when muscles adapt themselves successfully to flexible shoes.

If changes are made from stiff types possessing moderate flexibility to flexible types having moderate stiffness, there should be expected only a moderate increase in muscular strength. Feet will increase in strength up to limits of their adaptability if they are forced by increased exertions in very flexible shoes; and dangers of strain increase as limits of adaptability are approached, for development sometimes is forced too hard. Feet may become harmfully overstrained in flexible shoes although they permit highest grades of muscular development.

Stiff shoes protect feet against unusual external injuries, the protection varying with thickness and resistance of soles. Most workmen engaged in heavy labor, pick and shovel laborers, bricklayers, teamsters, structural workers, foundry workers, and very many others in many occupations find heavy soles best suited to their needs. For example, a teamster whom the writer saw, slipped from his team and a cartwheel passed over his foot while the latter happened to be turned on its edge on the ground. The heavy sole was buckled considerably, and four foot bones were cracked; but if there had been a light flexible sole the foot would have been very badly crushed. Any structural worker who has to stand on ladders, or narrow edges of timber, or steel work, has little use generally for very flexible shanks. Flexible shoes are for those who do not have to abuse the feet unavoidably.

All persons should wear as flexible shoes as their occupations and habits permit, without undue risks from overstrain. This is so because muscles increase in strength and size by proper care through years of activity until practically they become permanently strengthened. Strong feet may lose strength slowly under continually slightly unfavorable conditions, until they may become so greatly weakened after many years of abuse that they never recover their former degrees of normalcy.

Let shoe clerks recall the fact frequently that muscles will succumb to nervous-vascular influences whenever these combinations become bad enough, whether flexible or stiff shoes are worn and regardless of perfect shoe fitting.

Fairly satisfactory combinations of protection and freedom usually are obtained in fairly stiff, flexible shoes or in fairly flexible, stiff shoes. These two types should be used by the majority of individuals most of the time rather than extremely flexible shoes or rigid arch supports exclusively.

What happens when a new pair of shoes are fitted? If degrees of shoe flexibility and stiffness lie within limits of muscular adaptability, there will take place new adjustments within muscles, either strengthenings or weakenings, until a satisfactory new level of equilibrium of muscular strength is established, assuming that amounts of work and kinds of occupations remain constant. Normally adaptable feet will adjust themselves to standards that may be near upper limits, or lower limits, or at innumerable intermediate points between limits of their adaptability, as occasion compels them to do.

Slight variations in standards from time to time may help feet to remain more easily adaptable than a single fixed standard used without change for years. Two slightly different pairs of shoes used alternately may not be as comfortable as a single variety used continuously, but if differences between the two are not so great as to cause discomfort while making changes, there is a probability that two pairs may keep the feet in good condition for a longer term of years. Apparently there is such a thing as too much and too continuous comfort for an individual's welfare.

Stiff soles are useful as range of adaptability lessens in old age, in obesity, in chronic joint diseases, in debility, and in rheumatic states or muscles due to faulty nervous-vascular combinations acting on them.

Arch supports possess certain advantages and disadvantages. Among advantages should be mentioned (1) ease with which they may be employed as temporary appliances for temporary weaknesses; (2) ease with which they permit finer adjustments in fitting weakened feet; (3) increase in range of support that is obtainable with a single pair of shoes by their use; (4) possibilities they afford of furnishing more support than is attainable with stiff shoes; (5) convenience to patients under certain conditions.

Disadvantages include (1) ease with which supports may be employed by wearers for too long periods, thereby lowering unnecessarily the level of muscle strength maintained; (2) ease with which maladjustments are possible when supports are carelessly fitted, or when underlying physiological principles governing their use are not understood; (3) need of some supervision generally after fitting for best results; (4) damage to shoes.

Experiences of very many wearers of arch supports include satisfactory first periods in which feet are made more comfortable from relief afforded weakened muscles. Supports continue then to be worn too long if they are comfortable, or until they break or wear out. During this second period, feet weaken down to such levels as degrees of extra support permit them to do. Finally when they are discarded there are feelings of freedom and increased strength which cause wearers often to condemn all supports unfairly. Blame should rest with physicians or shoe fitters who do not explain intended purposes and limitations of appliances clearly. Events of similar nature sometimes take place when extremely flexible shoes are worn beyond capacities of their wearers for adaptation. Then flexible shoes are condemned unjustly for harmful strains that are produced.

Arch supports should not be fitted hastily without thought of severity or duration of existing foot weakness, nor when opportunities are lacking for future observations.

There are no good reasons why shoe clerks should not be able to fit arch supports skillfully as well as shoes, provided they have proper supports. Some shoe stores already have installed successfully special fitting departments with foot experts in attendance; so that many customers are fitted entirely satisfactorily.

Careful orthopedists are strongly opposed to such direction of development, however, because they feel that these are encroachments on their rightful domain. They favor shoe dealers strongly who do not bother with supports. Proper use of appliances being more than temporary perfect local adjustments, there are forcible arguments in favor of co-operation between shoe merchants and orthopedists for improved service to wearers. More shoes and fewer supports are likely to be used under a co-operative system, while patients may receive more frequently special medical advice, with deliberate directions such as cannot be given in a busy shoe store emporium. Dividing lines between domains of shoe merchants and fields of activity of the medical profession are bound to be uneven in different localities, due to widely varying conditions. Total condemnations, therefore, of any special methods have to be made very cautiously.

Arch support makers are entitled to their place in the sun. There are large commercial concerns which turn out enormous numbers of satisfactory appliances, and the latter are fitted properly perhaps almost as many times as they are misfitted now. There are medical appliance shops which specialize on fitting all kinds of medical apparatus including foot plates. One unique combination that the writer has found is a modest shop in Lynn, Mass., run by a very progressive old shoeman, Everett H. Dunbar, who has been in turn a successful custom shoe maker, retail shoe merchant, arch support maker and wholesaler. Now in his declining years he enjoys the confidence of many doctors and others because he can handle personally, if necessary, all phases of his problems, shoe fitting, cutting and tempering of steel plates, and leather work of support making. He makes his supports for his customers individually while they wait for him to assemble the necessary parts. He fits carefully peculiarities that exist, and it must be admitted that individual fitting in arch supports, as in shoes, is the acme of perfection provided the work is done skillfully. Orthopedic specialists have very complete apparatus shops where they manufacture all of their own appliances in some instances.

Many orthopedists are using metal supports less frequently now than formerly for longitudinal arches, but there must remain a certain steady demand for them. On the other hand, there appears to be an increasing number of simple anterior arch pads of various descriptions needed for anterior arch troubles. High heels and pointed toes in women's footwear, or corrective shoes used increasingly among men for impossible tasks, both contribute to the demand for anterior pads.

Particularly those types of very flexible, extremely corrective shoe shapes, which although they have definite advantages, nevertheless are fitted too short many times. Back pressures are produced on outer toes and transmitted to anterior arches which in turn become weakened and painful. When feet become sufficiently weak there are no shoes made that alone will hold feet in proper shape, and very commonly in these instances the shoe fitter is overlooking some nervous-vascular defect that should be receiving proper medical attention, and which is ruining the customer's feet as well as the shoe fitter's reputation.

It would be possible to go on raising objections to, or commending every trivial detail of every shoe or support in some isolated circumstances at least, until an intolerably complicated discussion might be developed. Let it be remembered, therefore, that there are natural corrective tendencies which take care of most temporary troubles after a longer or shorter time, and that shoes, supports, medical care assist these if skilfully managed.

CHAPTER XVII

FRONT PARTS OF FEET AND OF SHOES—ABORIGINAL FEET

AN INTERESTING FOOTPRINT ILLUSTRATES VERY WELL IN THIS CHAPTER THE EXPANDED TYPES OF FEET FOUND IN BAREFOOTED RACES. BY COMPARISONS THE FACT MAY BE SEEN READILY THAT ALL FEET ARE RESTRAINED CONSIDERABLY BY SHOES. ANTERIOR ARCHES OF FEET, WHICH ARE SERIES OF BONES TRANSVERSELY ARRANGED WITH INTERSPACES BETWEEN THEM BRIDGED BY FLEXIBLE LIGAMENTS AND MUSCLES, CANNOT STRETCH AND EXPAND IN SHOES AS WHEN FEET ARE WHOLLY UNRESTRICTED.

ANTERIOR ARCHES OF MANY NORMAL FEET MAY BE WHOLLY OBLITERATED OR REVERSED AT WILL. THEIR SO CALLED NORMAL ARCHING IS PRODUCED BY ACTION OF MUSCLES THAT FLEX TOES DOWNWARD. THE PULL OF FLEXOR TENDONS OF TOES TENDS TO ELEVATE THE BALL OF THE FOOT AT ITS CENTER; BUT PRACTICALLY IN WALKING THIS ACTION IS RESTRICTED MERELY TO PREVENTING THE ANTERIOR ARCH FROM SAGGING DOWNWARD AT ITS MIDDLE. THE BALL OF THE FOOT IN WEIGHT BEARING IS NOT ARCHED BUT PRESSES EVENLY AGAINST THE SURFACE ON WHICH THE FOOT IS PLACED. POORLY SHAPED OR POORLY FITTED SHOES VERY COMMONLY FORCE MIDDLE SECTIONS OF FRONT PARTS OF FEET DOWNWARD UNEVENLY SO THAT CALLUSES OR TOE DEFORMITIES DEVELOP.

Anterior regions of feet possess features of special interest. They become broadened into "splay" feet under certain circumstances; and in other instances are squeezed by narrow shoes continuously until the question arises as to what represents ideal form for front parts of feet.

If answer is sought from observations of aboriginal feet, the fact must be remembered that feet of primitive races may exhibit some defects, although unshod, and that these defects should not be adopted as standards. There are inferior, weakened, barefooted types, as there are inferior developments among some feet of civilized races.

Tropical South Sea Island natives were pictured in the first chapter, and young, well-developed individuals were chosen purposely for illustration. What kind of feet do primitive natives of colder regions possess? For example, what foot peculiarities are shown by inhabitants of Tierra del Fuego, at the extreme southern tip of South America where the climate resembles somewhat the climate of Labrador? Certain tribes that inhabit this island are large, rugged aborigines, who are often six feet tall, who still use bows and arrows, and who employ skins of animals for clothing.

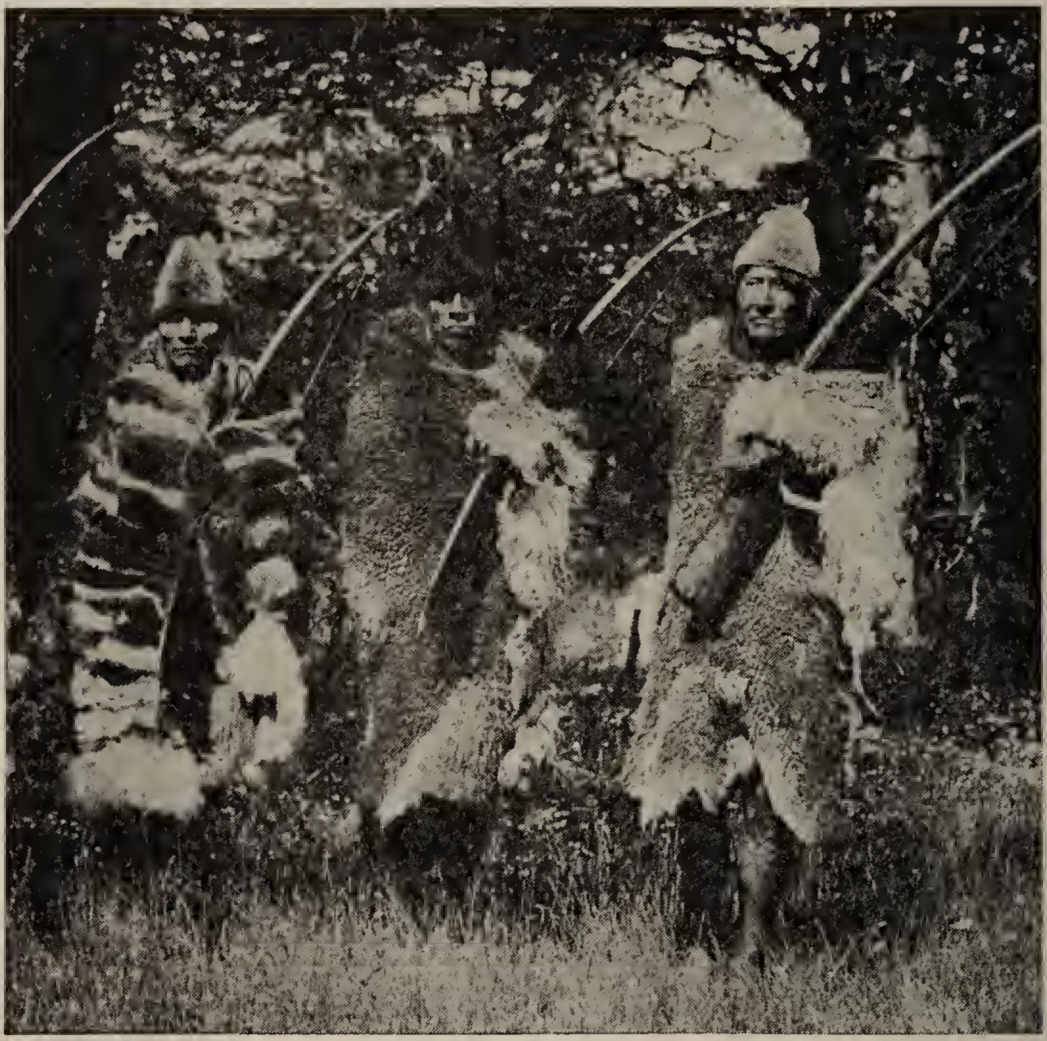

Figure 50—Fuegian natives. The individual at the readers' right in the picture is the person whose foot impression is reproduced in Fig. 51.
These Amerinds (American Indians) are tribes that Charles Darwin considered at one time showed the lowest type of human intellectual advancement; but who Colonel Furlong has proved to be inherently intelligent, although the most primitive people in the Western hemisphere. Their only garb is a single guanaco skin thrown over their shoulders. Copyright by Charles Wellington Furlong—Republished by special permission.

Thanks to an expedition of Charles Wellington Furlong, explorer and writer, it is possible to reproduce here a Fuegian footprint and a photograph of the man from whose foot it was made. The writer is greatly indebted to Lt. Colonel Furlong for these pictures which form a

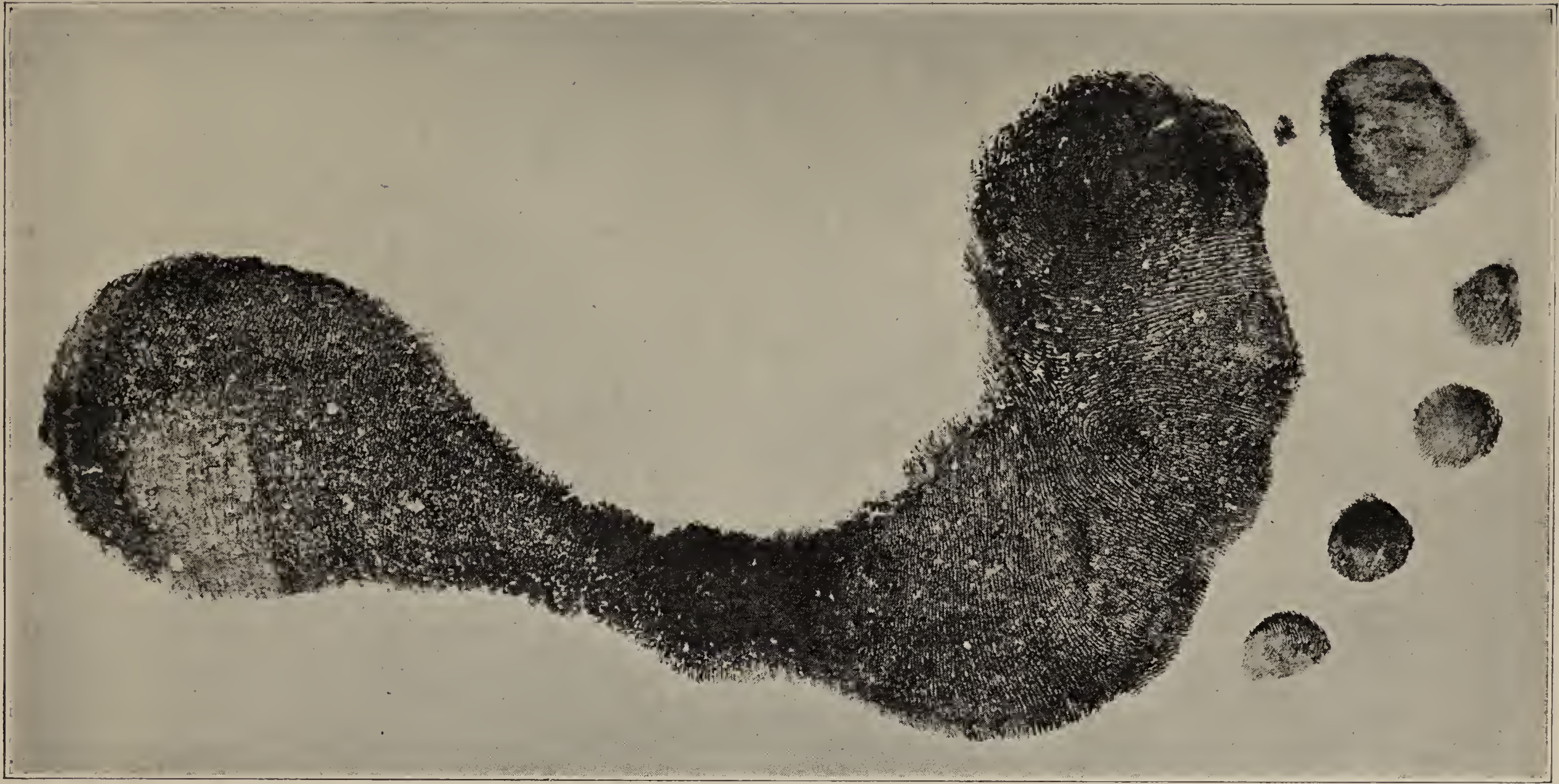

Figure 51—Foot print of a native of Tierra del Fuego, South America.Lt. Col. Charles Wellington Furlong made this print from an Ona Amerind named Pupup, at Najmish, Tierra del Fuego, on January 19, 1908

part of still unpublished articles of his on ethnological topics. Readers are more familiar probably, with Mr. Furlong's striking pictures of cowboys, steers, horses and other animated scenes of western life in his book—"Let 'Er Buck."

Here is a particularly suitable standard-type of footprint for study. See Figure 51. Notice that the ball of the foot is remarkably broad and well-developed, not stretched and weak. Toes are far apart, and the second toe is the longest one. The bearing surface of the heel is only one-half the width of the bearing surface of the front part of the foot. The outline running forward from heel to ball on the outer side is concaved. The longitudinal arch holds up the inner side of the foot well, so that the outline running forward from heel to ball on the inner side makes a deep hollow under the foot, leaving only a narrow isthmus of bearing surface to connect heel with front parts along the outer edge of the foot.

The longitudinal foot axis passes through the middle of the heel and through the third toe. If a straight edge is placed so as to touch inner boundaries of bearing areas at heel and ball, the great toe print will be seen to be deflected about one quarter of an inch from the extended straight line. Muscular development and stature of the person are seen to be excellent from the photograph.

Photographs of South Sea Islanders show their feet broadened similarly. It is common to observe similar expansions also among certain feet that have been shod, when for any reason front parts have been used exceptionally. Notably there are some individuals who have a shortening of one leg with an inability to make the heel of the shortened extremity touch the ground. In consequence body weight is supported on the ball of the foot more than usual; and then a serviceable anterior region develops that resembles the aboriginal type in breadth, although not in its toes.

Primitive foot prints appear strange, because continuous wear of shoes in civilized peoples has prevented natural expansions of flexible anterior arches. It is the continuous prevention of expansion, or even gentle continuous squeezing throughout years of growth that leads to narrower fixed types of adult shoe-clad feet. Presumably if all shoes were made of aboriginal foot proportions, and if they were worn continuously from childhood, then we should all have primitive-shaped feet.

Which are better, primitive or civilized types of feet, and why? Primitive races probably do not have nerves running to toes pinched in the way shoes apparently pinch nerves in the ball of the foot not infrequently. Toes of aboriginal types are undoubtedly stronger and more serviceable, especially the smaller toes.

If two barefooted natives of equal strength and endurance were subjected to same tests, one fitted carefully with shoes that suited his foot peculiarities perfectly, while the other remained unshod, it might be found that advantages of shoe protection outweighed advantages of complete freedom, so that on theoretical grounds and from accumulated practical experience there seem to be no good reasons for reversion to primitive foot shapes. However, the latter are instructive, and useful as standards from which to measure degrees of deformities that are being produced by modern shoe styles. Deforming tendencies should not be allowed to exceed certain reasonable limits that are being passed now in many types of fashionable shoes.

Objectionable features of high-heeled, pointed shoes are the lack of adequate toe space and the fact that they are commonly fitted too short. Toes are squeezed laterally as well as curled into contracted positions by back pressure from the tip of the shoe. Flexible anterior arches are forced downward in direction reverse to the position normally held during active use. Shoemakers have found that if lasts are made with hollows under anterior arches that balls of feet can be pushed down into this space so that slightly smaller shoe sizes can be endured. There is nothing to commend in these styles except their fashionable features, and fortunately the latter now are being lost, temporarily at least.

Extreme inswinging, flexible shoes are objectionable for use with weak feet except for very short intervals. Rather short fitting of these flexible types gives a comfortable feeling of support to weak feet at first, and back pressure on outer toes often forces anterior arches downward so that increasing anterior foot troubles are being noticed with increased use of such types of footwear.

For strong feet, or for weak feet for extremely short periods, flexible inswinging types possess positive merits. They may be utilized to exercise weak feet in combination with stiffer shoes. The writer does not disapprove of squeezing the feet moderately, if desired, for a few hours occasionally, in fashionable shoes. This abuse is no worse than abuses which aborigines subject their feet to without harm. Slight abuse may even amount to a virtue from the point of view of maintenance of foot adaptability; and it is continuity or too great frequency of abuse that should be strongly deplored.

CHAPTER XVIII

FOOT PROPORTIONS AND SHOE PROPORTIONS

NO TWO FEET ARE EXACTLY ALIKE, BUT MOST OF THEM HAVE TO BE FITTED FROM GRADED SERIES OF SHOES POSSESSING VARYING SIZES AND PROPORTIONS. PUBLIC INTEREST COULD BE STIMULATED IN SHOE PROPORTIONS AND FOOT PROPORTIONS IF SHOES WERE MORE PLAINLY AND RELIABLY MARKED; AND INCREASED PUBLICITY IN DETAILS OF SHOE CONSTRUCTION WOULD STIMULATE PROGRESS IN DIRECTIONS THAT WOULD BE PROFITABLE TO SHOE MAKERS, SHOE MERCHANTS AND SHOE WEARERS.

If a large number of foot bones were collected, including all bones found in feet, with many of each kind from many sources; it would be discovered on comparison of specimens of each different type that numerous variations existed. Heel bones would exhibit differences among themselves, or toe bones as well as all others would show some variations. These variations include differences of size and of proportions.

There are short broad feet, short slender ones, long slender ones, long broad ones. There are feet in which heels are large, small, or of intermediate sizes in comparison with transverse measurements across the ball of the foot. There are feet in which toes are relatively long or short in comparison with total foot length, or compared with heel to ball measurements. Arches may vary in height among feet of the same length. Some feet present a straight appearance, while others are inswinging or outwardly curved along the axis from heel to toes. The same foot may show variations in straightness from time to time.

INDIVIDUAL PECULIARITIES IN ALL FEET. If a sufficient number of different measurements of feet were made, there would be found to be individual peculiarities in all feet. Each foot is different from all others in some barely perceptible detail at least. Classifications of sizes and proportions have to be made for practical purposes, however, that disregard smaller more unimportant individual differences.

Is a foot to be considered simply a peculiarly shaped object that needs to be covered, as a shoe last is covered, with leather smoothly under slight even tension or absence of tension?

How Shall Feet Be Fitted? The answer is that feet should be fitted with shoes sometimes smoothly and evenly, and at other times they should be fitted with pressures of endurable degrees increased locally at certain areas to assist weakened muscles, or, at times with unusual freedom from pressures locally at sensitive points. Feet that are evenly balanced, attractively shaped, and normal in function should be fitted with shoes of corresponding shape and similar balance, smoothly, evenly, loosely.

Feet may be fitted to shoes that increase pressures locally when longitudinal arches are sagging. Increased local support may be furnished by specially constructed heels, or stiff shanks and counters, or independent orthopedic plates, or by shoes that shift strains by permitting changes of foot postures. Combinations of these methods are used profitably.

Weakening front parts of feet may require shoes that are fitted snugly; and shoes may be constructed with special combination measurements for this purpose. Or instead, independent arch supports or arch cuffs may be utilized. Sore and irritated toes on the contrary may necessitate snugly fitted heels with unusual room and freedom from pressure in affected anterior regions.

Corrective Measures Exert Force. Corrective pressures, in distinction to simple supportive ones, have as their object the restoration of normal shapes besides the support of weak muscles and ligaments if the latter is needed. Corrective measures may not be designed primarily for immediate comfort, and not infrequently they exert as much force as an individual can tolerate.

Shoemen and orthopedists both are agreed that specially constructed heels are to be recommended very often. Shoe fitters are inclined to extend the range of usefulness of footwear by trying to employ shoes as active corrective appliances. Many orthopedists on the contrary favor corrections of feet by independent appliances first, advising the fitting of shoes evenly and comfortably afterwards to feet that are adequately held in improved postures with supports. Most pronounced foot defects can be well held only by carefully adjusted appliances, while attempts at holding such feet by any special shoes alone lead to new complaints not infrequently. Much may be said in defence of shoes as passive coverings possessed of no alleged corrective features.

How many lengths, widths, and special combinations of shoe measurements are needed to fulfill all requirements imposed by the large variety of foot sizes and foot proportions?

Customers Like Simple Methods. From a mechanical standpoint, the greater variety of shoes available, the better can be the fitting when all are conveniently at hand. Shoe merchants naturally wish to use the smallest number of shoe combinations that will give satisfactory practical results. Wearers of shoes favor as a rule those methods that are simple and inexpensive; and, however meritorious the ideas of shoe merchants or doctors may be, such ideas have to appeal favorably to customers.

There are many good shoes made now, yet it is impossible for an average customer or a medical practitioner to compare shoes of different manufacturers with accuracy and facility. The public and the medical profession need further education regarding shoe construction, last measurements, and combination measurements that are used, as the majority do not know even that a standard set of last measurements has been adopted already by the National Shoe Retailers Association. Many manufacturers have been rather reticent about making known all facts concerning their best selling styles in order to delay possible copying by competitors. Furthermore, lack of uniformity in marking of shoes by different makers has been extremely conducive to confusion in minds of laymen regarding established standards.

Feet of Variable Proportions. No such thing exists of course as any single fixed set of standard shoe measurements that will fit all persons; or that all persons should attempt to mould their feet to by forcing the latter into shoes of exactly same proportions. Figure 52 was introduced to help give a clearer realization that feet are fundamentally of variable proportions, that shoes have to be of variable proportions for best fittings uniformly of any large number of individuals.

Educate Public on Peculiar Proportions. It is the writer's belief that special campaigns of publicity and education would yield increased sales of those shoes that are completely and plainly labelled so that every one can see easily their precise peculiarities.

While it may be said truthfully that the majority of customers perhaps are indifferent to footwear details as long as their shoes look attractive and are reasonably comfortable, yet there are very considerable numbers of people now who would adapt themselves quickly to new information furnished them. Does it not seem probable that, as many customers realize more clearly the peculiarities of their own feet, they will search for and discriminate increasingly in favor of shoes correspondingly best with their own types? Just as many or more shoes would be sold with increasing knowledge, there would continue to be many new styles, and progress would be tending in desirable directions.

Lasts. The public ought to know universally, as shoe fitters know already, that some shoes are made with heels which are one or more sizes smaller than ball measurements; that others are smaller or larger at waist or instep than standard requirements call for. More information should be given about actual widths of weight bearing surfaces in ball measurements, as well as usual or unusual lengths from heel to ball, or from ball to toe. These details are important shoe peculiarities as well as the flexibility of shanks, swing of lasts, shape of toes, and height of heels. These measurements should be marked simply on shoes for easy inspection of customers and in uniformly intelligible manner. Many customers and doctors are eager to learn these peculiarities of proportions, and manufacturers who supply this demand may discover that reasonable publicity is more profitable than obsurity of marking.

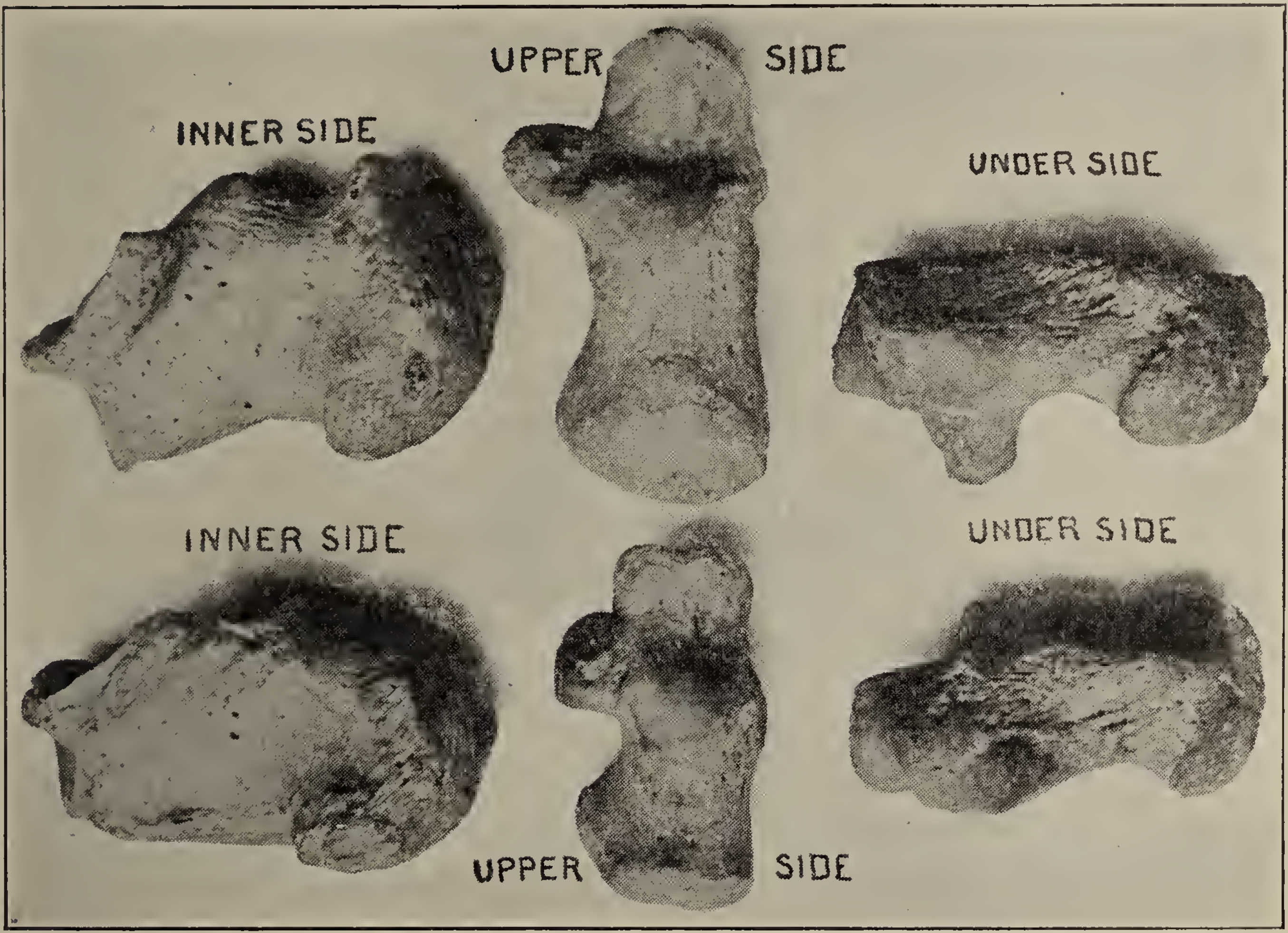

Figure 52 shows six different heel bones that illustrate how a single type varies. Different sides of the six bones have been photographed to show that surface, processes, and bony contours correspond clearly with each other, yet are noticeably unlike in their lesser details. It is easy to imagine from such dissimilarities when all minor variations of all foot bones are considered collectively, that complete groups of bones will differ noticeably in size, proportions and posture. Such variabilities of foot sizes and foot shapes are well known to shoe fitters.

CHAPTER XIX

INFLUENCE OF FOOT POSTURE ON SYMPTOMS IN BACKS, HIPS AND KNEES

Pains in calves of legs or lower regions of back are induced sometimes by abrupt changes from high heels to low ones. Low heels may give sensations of tipping backward in standing under these circumstances. Flattened longitudinal arches may produce painful strains of ligaments at the knees, or they may cause muscle strains about the hip. These symptoms may be noticed without local trouble of appreciable nature in the feet; so that physicians may find causes for various disabilities that are referable to foot defects, or to poor shoes, which patients are wholly unaware of themselves.

Abrupt changes of foot postures from high heels to low ones may alter poise of the body sufficiently sometimes to produce backache; while at other times symptomless flat feet may place strains on knee ligaments so as to produce or aggravate knee troubles apparently.

Many orthopedists lay much stress on these slight changes of posture, and it is certain that feet should be observed carefully when symptoms in backs, hips or knees are complained of, as otherwise contributing causes of troubles may be overlooked in the feet.

Possible Relief of Mild Aches. Occasionally knee troubles may be relieved apparently by building up inner sides of heels so as to alter distribution of strains at the knees. Half an inch of uniform elevation of one heel may relieve a mild ache in the back or hip sometimes because this may shift strains in favorable ways that are being borne by muscles in the lower part of the trunk.

Too much emphasis should not be laid on these minor adjustments however, the writer believes, although they occupy positions of deciding importance occasionally; for there are other factors which have to be considered in every instance. Backs, hips and knees are influenced through the same four main channels that have been described as affecting feet, namely, through nervous and through vascular paths, through external means, and by variable mechanical stresses and strain which muscles and ligaments resist or exert on the stated regions in normal bodily activity.

If a person is in excellent physical condition with average adaptability then slight variations in heels do not produce appreciable effects; but, if muscles and ligaments have been gradually weakened to the point that they are beginning to break down in normal function because of abscure influences acting on them through circulating blood, then slight changes of foot posture may relieve or precipitate the threatened breakdown in the feet or elsewhere.

A Common Combination Complaint. It is a very common occurrence to have patients complain of their feet and their backs simultaneously. Some enthusiasts explain back symptoms under these circumstances as representing results of foot defects wholly. Probably they are justified in believing that foot postures exert some influence on back symptoms, but certainly many of these suffering individuals are debilitated and seem to be influenced also through nervous-vascular channels in unfavorable ways. Better balanced interpretations will take into careful consideration all circulatory and postural peculiarities, and most effective treatments will include local corrections of foot defects together with simultaneous attention to rectifications of nervous-vascular influences which are acting directly on the back muscles.

Doctors and Merchants Should Co-operate. As these facts may have important bearing on fitting of shoes at times, it seems that attention should be called to them in concluding this series of medical papers for shoe merchants and shoe clerks. The final idea that should be left in minds of readers is that increased intelligent co-operation between the medical profession and the shoe trade should be one of the important lines of future progress.

Some Ideas for Discussion. Much more might be written, but readers presumably have been taxed to limits of tolerance by these condensed articles already, and careful review of what has been explained would be more profitable now than additional information. The next logical step to gain better understanding would be the direct interchange of medical ideas by conferences of orthopedists with shoe men over real problems and actual persons who are wearing shoes. Why should flexible shoes be avoided usually while body weight is diminishing? What advantages has most precise fitting of shoes if two or more styles are beneficial for those who can afford several pairs of shoes? Why should there have to be an expensive, very complete stock of all sizes and widths for medical purposes? Why be restricted to the sale of single types of shoes, instead of selling from smaller stocks of several types, and with more rapid turning over of the stock? These are samples of ideas that must be discussed for greatest profit in more intimate, freer manner than is permitted by a few written pages.

PERSONAL EXPERIMENTS IN WEARING ORTHOPEDIC SHOES WITH INTERPRETATIONS OF RESULTS, AND WITH OTHER COMMENTS

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PART II

PERSONAL EXPERIMENTS IN WEARING ORTHOPEDIC SHOES WITH INTERPRETATIONS OF RESULTS, AND WITH OTHER COMMENTS

CHAPTER XX

Experiences that are to be related were planned after opinions of many orthopedic surgeons and those of shoe merchants had been collected regarding shoes and feet; also after the writer had prepared a series of 18 brief non-technical medical articles on feet for the *Boot and Shoe Recorder*. Logically the next step was to confirm ideas more convincingly by actual wear of shoes experimentally.

Single styles of footwear might be tried on various types of feet; or various types of shoes might be tried on a single pair of feet. The latter method was chosen.

The writer's own feet were selected because they are obliged to carry around 215 pounds and have proved equal to their tasks for 45 years. Foot arches have sagged under their burden, but they represent symptomless, flexible, flat feet possessed of good functions and strong muscles.

A limited number of pairs of shoes can be worn by a single individual; and therefore in selecting shoe types for experimentation, many excellent shoes had to be passed by. The writer in his inexperience presumably slighted those makes of shoes that were not advertised in trade journals when his selections were made. It was found also that a few manufacturers did not care, or perhaps did not dare, to have their shoes worn experimentally by a person unknown to them. For all shoes have their limitations as well as positive merits. None are perfect in all respects.

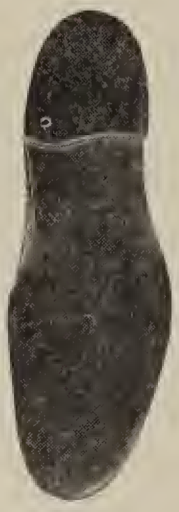
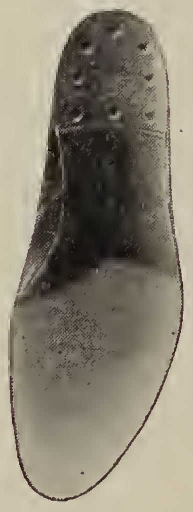


Fig. 1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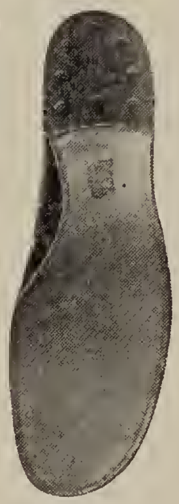
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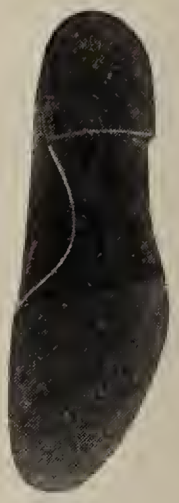
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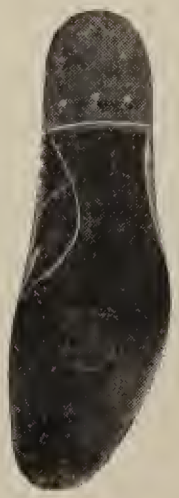
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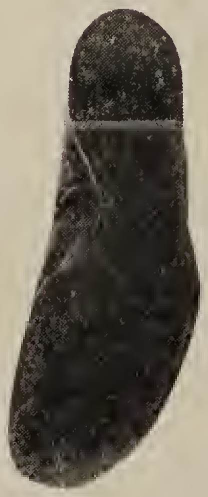
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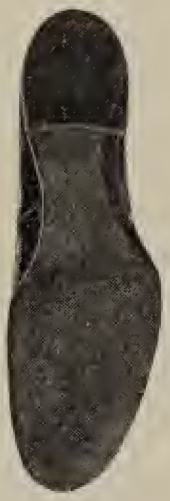
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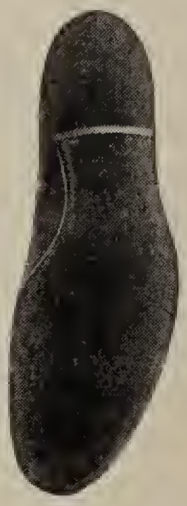
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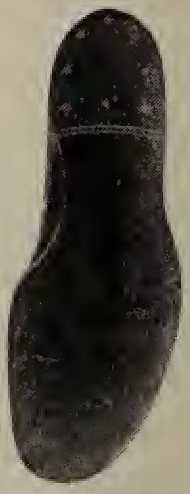
Fig. 9

1. Anatomik shoes made by Field & Flint Co., Brockton, Mass.

2 Arch Preserver shoes made by E. T. Wright & Co., Inc., Rockland, Mass.

3. Educator shoes made by Rice & Hutchins, Inc., Boston, Mass.

4. Everest and Supple Tread-types made on Last 62, by Lewis A. Crossett Company, No. Abington.

5. Glove Grip shoes made by M. N. Arnold Company, No. Abington, Mass.

6. Ground Gripper shoes made by Ground Gripper Shoe Company, East Lynn, Mass.

7. Trupedic shoes, made by Churchill & Alden Co., Brockton, Mass.

8. Sorosis shoes, the A. E. Little shoe, made by A. E. Little Company, Lynn, Mass.

9. Hilgert Inner Mold shoes, made by The Emerson Shoe Company, Rockland, Mass.

As a matter of policy, therefore, this report had to be restricted to positive merits and peculiar advantages of each make of shoes discussed. It had to be honest and impartial. The experimenter had no personal interest or prejudice in favor of any single shoe used. None were selected for which approval could not be given honestly. Names of manufacturers who have risked their special products in justice have to be mentioned, and the writer is glad to be able to approve of all styles he selected, each within its special field. He is glad to mention merits of different shoes in strictly impartial manner, but cannot endorse any shoe for exclusive advertising purposes.

Photographs have been utilized to simplify descriptions of shoe types, and these illustrations show appearances that are not depicted usually in attractive conventional style cuts; for the photographs were taken with the foot in the shoes while weight of the body was producing tensions, pressures, and wrinkles. As a physician should not attempt technical shoe descriptions none will be made.

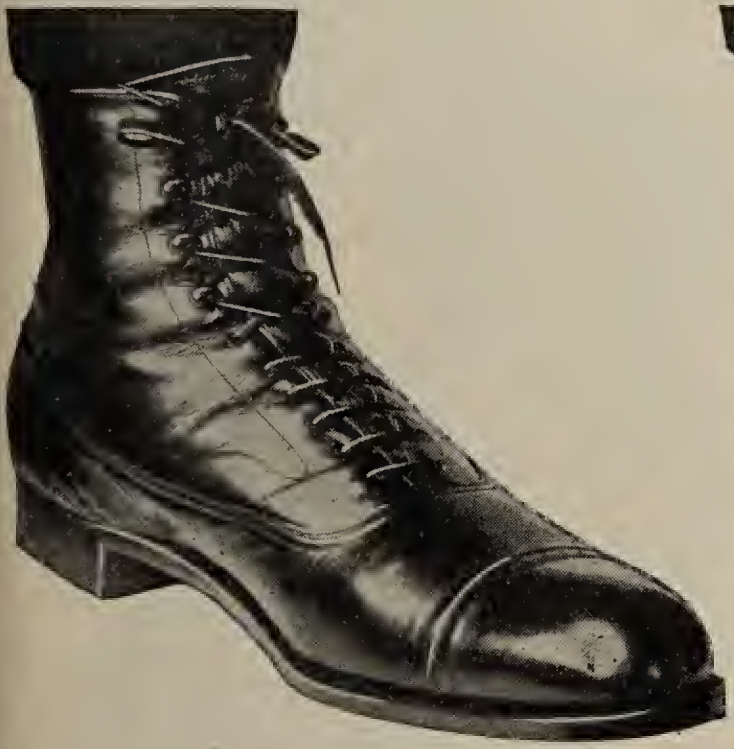

Fig. 10
Anatomik

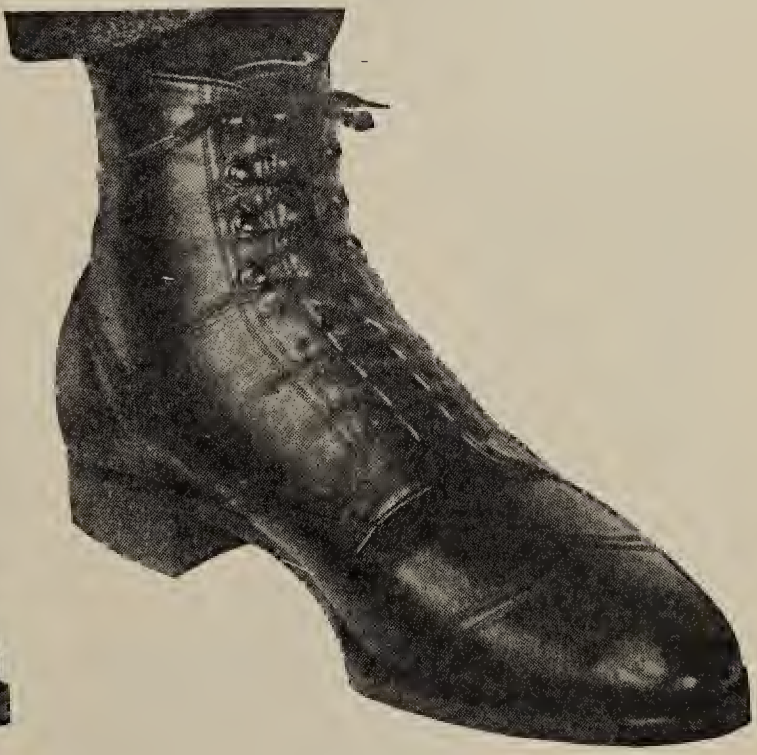

Fig. 11
Arch Preserver

Anatomik Shoes possess broad stiff shanks, long, invisible stiff counters, and orthopedic heels. They are made on patented lasts for which the claim is made that shoes built on them support feet at proper points, without causing undue pressure on blood vessels situated under the instep. They are said to be "simply good looking, stylish shoes, evidencing the very best materials and shoe workmanship." They were found to be comfortable and very satisfactory in the experiments. The last with a "London toe" is figured, but they are made also in squarer "Anatomik" toes. Some are made with smaller heel measurements.

Arch Preserver Shoes that were worn were made especially attractive with soft toe caps, and with particular attention paid to good looking features. Hearty approval of workmanship shown and comfort afforded is possible. They possess the important peculiarity of having a specially constructed broad, thin metal shank, that is angulated instead of flattened in order to make it more rigid. It is fastened securely in the shoe so that the latter cannot stretch or sag between heel and ball. These shoes have snug heels and broad measurements across the ball. Measurements from heel to ball are longer than are called for by standard last measurements. The effect of this combination is to give a stiff shanked shoe with a roomy front part.

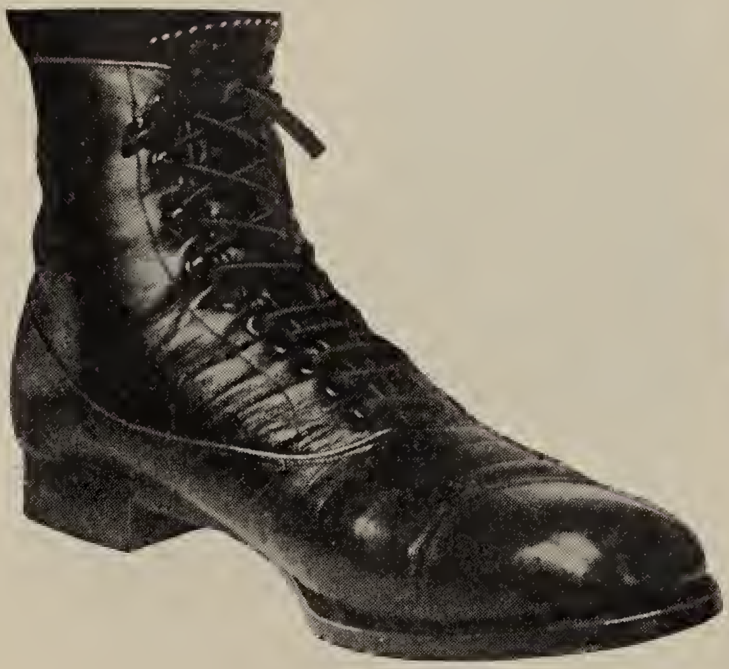

Fig. 12
Educator

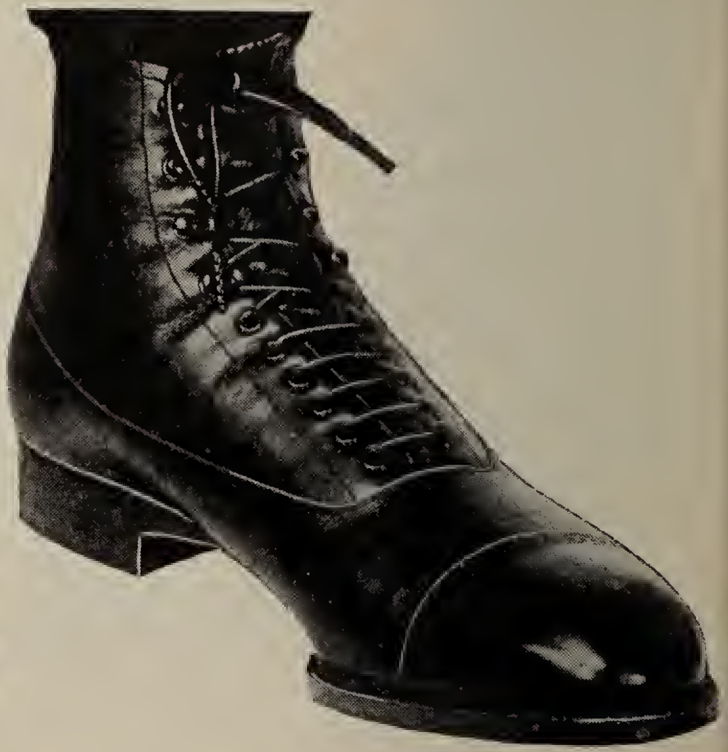

Fig. 13
Supple Tread

Educator Shoes are made on straight lasts and possess medium flexible shanks. Instep measurements are less than called for by standard last measurements, and consequently feet are held snugly at insteps while toes have plenty of room in this last. Educators are made in modified form on lasts with more rounded toes. They are very good looking shoes that possess a very wide range of usefulness.

Everest and Supple Tread Types made on Last 62. The former has an unusual thick non-metallic shank extending in a forward direction from the heel a short distance. The claim is made that it supports the posterior half of the foot and leaves the anterior half free and flexible. The shank helps to prevent sagging just in front of the shoe heel. Supple Tread shoes have medium flexible, shanks with extremely short steel reinforcements. Both types are cut away rather deeply under insteps. Instep measurements are less than called for by standard last measurements. Both styles were worn and were practically indistinguishable from each other in the freedom that they afforded the feet. They are particularly good looking, comfortable shoes, combining fashionable and individual features.

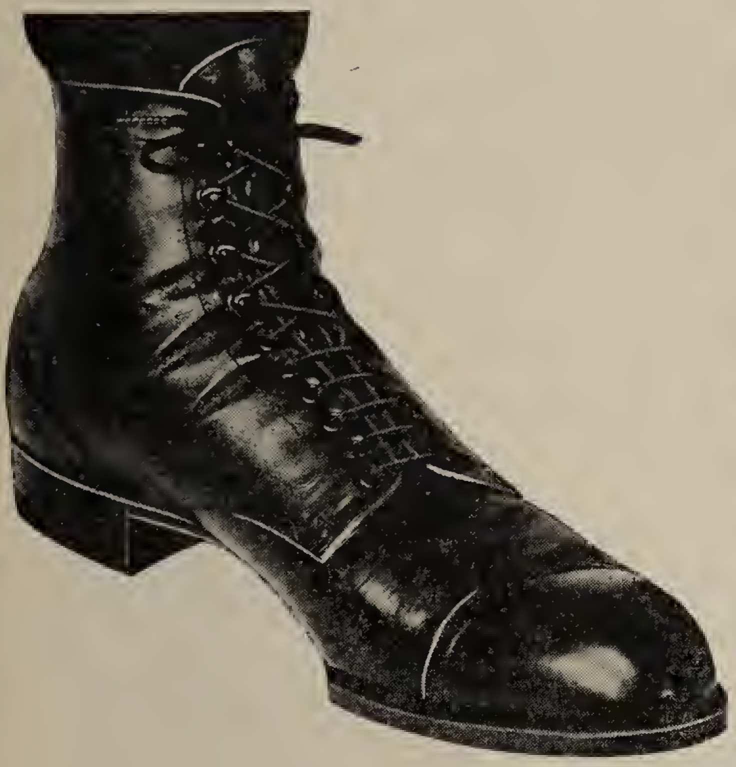

Fig. 14
Glove Grip

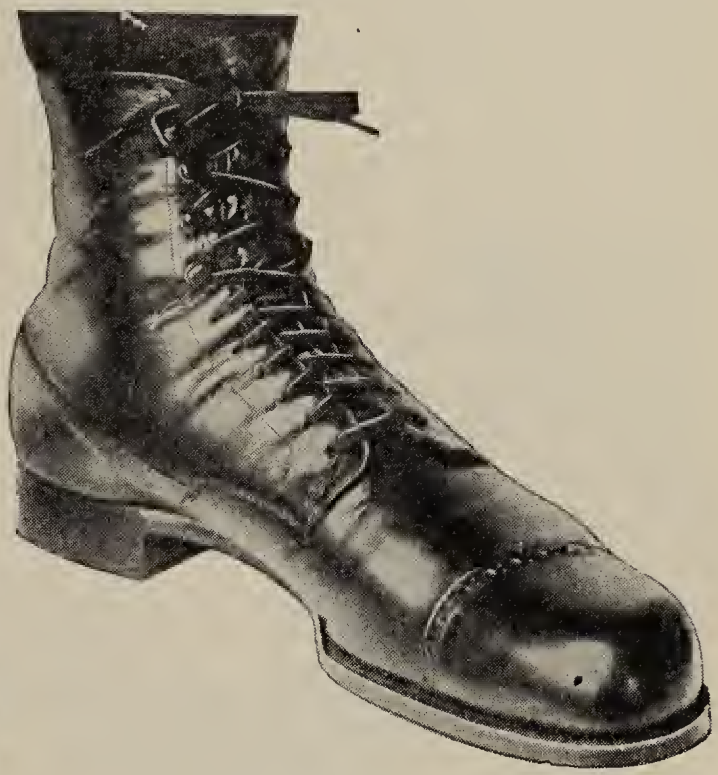

Fig. 15
Ground Gripper

Glove Grip Shoes are constructed like a bandage or sling for the instep. Soft upper leather sweeps snugly around beneath the instep and under the foot to the outer side of the sole, where it meets upper leather coming down on the other side of the foot. Both edges of upper leather, are attached here to the sole closely together in the narrow shank region. The sole pattern is well cut away at the instep. The shoes give a feeling of unusual freedom, lightness and comfort. As shoes are laced snugly, the soft leather grips the foot as a glove holds a hand.

Ground Gripper Shoes have been advertised for so many years that their peculiarities are well known, namely, the very flexible shanks and sole patterns that swing inward to an exceptional degree. The pair used in the experiments were particularly soft, loose, and comfortable. These qualities stood out in pleasing contrast to support of stiff shoes or snugness of others.

Trupedic Shoes are made with three variations, for each size, in the swing of the last. The cut taken for the manufacturers' booklet illustrates this point. Fig. 16A. The outflaring type fitted the experimenter's feet best, and were very comfortable from the first moment they were put on. These shoes are endorsed by the American Posture League. They represent, the writer believes, one of the numerous refinements of shoe making that merits positive commendation.

Fig. 16
Trupedic

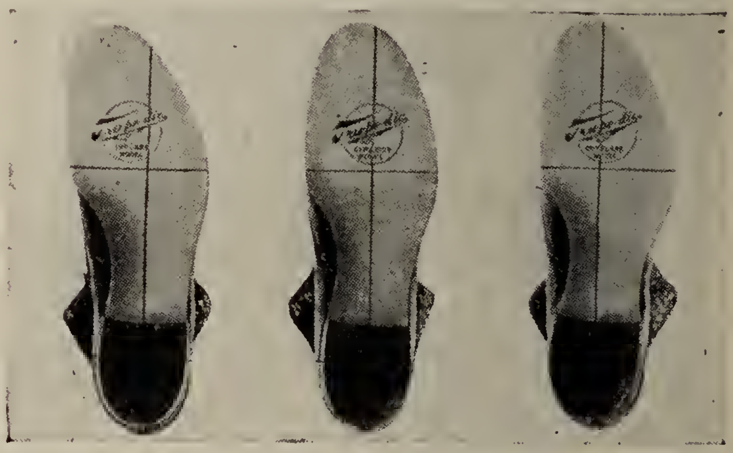

Fig. 16A
inflare straight outflare

The new *A. E. Little-Sorosis Shoe* has unusual stitching which gives tough, serviceable, flexible qualities. At the instep on the inner edge of the shoe from heel to ball it is stitched by new special machinery. Very firm lock stitches pass entirely through all layers of outer sole, inner sole, upper leather and heel counter. There is a special inside "saddle piece" included in the through and through stitching. The strong heel counter attached unusually securely to the sole at the instep, and also hugging the heel at its extreme posterior limit, helps to support the instep as the shoe becomes tense when sagging pressure is exerted by the body weight. The counter resists with a suspending pull upwards and backwards around the heel.

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An attractive looking, slender last was chosen purposely instead of a broader, rounded toe.

The manufacturers' contention that this type of construction gives more support than usual in flexible shoes, seems substantiated by the experimenter's brief experience.

The Hilgert Inner-Mold Shoe is a stiff shanked shoe with a removable innersole. The stiff shank serves one purpose. The innersole serves a different one that is overlooked in many excellent shoes. The inner mold has a very smooth surface of very finely woven thin cloth. Its heel portion is comfortably cupped and protects from protruding nails of the heel seat beneath. The inner mold fits very smoothly in the shoe, overlapping the upper leather in the region of the shank, and it covers completely the inner surface of the shoe sole. Skin of the sole of the foot is thus afforded a maximum degree of protection from irritation. These inner molds can be removed when shoes are taken off, differing in this respect from soft cushions built permanently into footwear. The Hilgert inner mold is firm, not soft, and it has quite complicated composition of which the principal part is leather and ground cork. The writer found this special combination of stiff shanks and inner molds a particularly comfortable one.

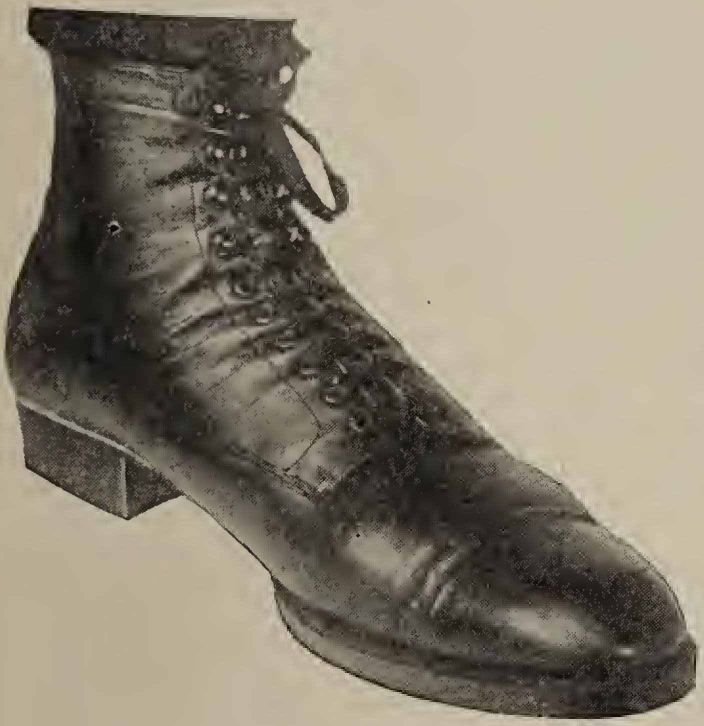

Fig. 17
A. E. Little Shoe

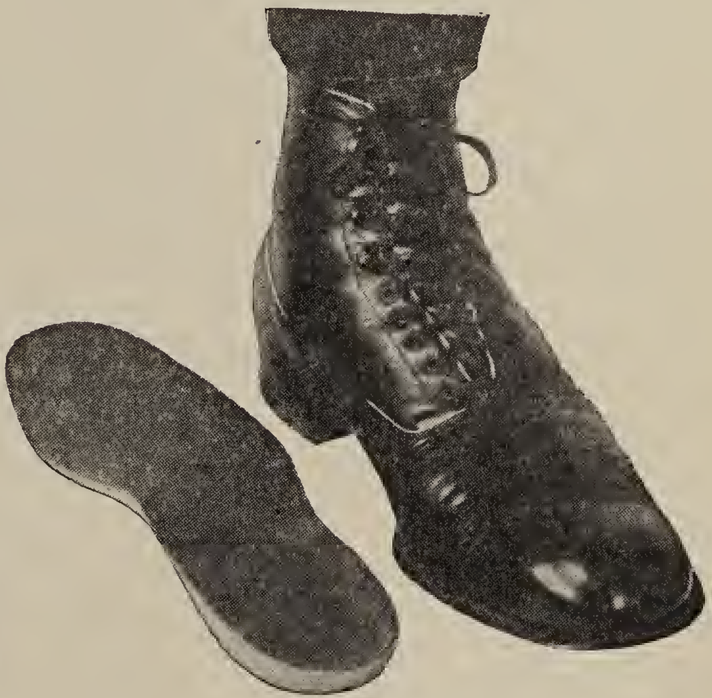

Fig 18
Hilgert Inner-Mold

CHAPTER XXI

PERSONAL EXPERIMENTS IN SHOE WEARING—Continued

The making of additional experiments with shoes is less important than making correct interpretations of the countless experiments going on daily without deliberate design by innumerable shoe wearers. Misconceptions, misinterpretations, unjust condemnations, unwarranted approvals, are inevitable when knowledge is so faulty in so many instances. Therefore, a few actual experiments with observations on their results will be utilized to introduce considerations of various disputed points.

Shoes were tried in preliminary manner for a day or so, as soon as they were received, in order to familiarize the experimenter with their peculiarities quickly. Different kinds then were alternated in various ways.

Stiff shoes for example, were worn one day and were followed by flexible ones for a day. Tightly fitted ones gave place to loose ones, short ones were replaced by long ones, and *vice versa.* Shoes of special combination measurements were alternated with those of standard measurements. One shoe from one pair was worn frequently on one foot, while simultaneously on the other foot another purposely mismated shoe was worn. Durations of time that different styles were worn continuously were varied. The experiments were incomplete in so far as very long periods of continuous wear for the shoes were concerned, because limited time did not permit each to be experimented with in the latter manner.

A continuous daily record was kept, but this is too long for publication. Names of different shoe makers in reports on experiments are purposely omitted to permit more freedom of discussion.

Experiment 1. A flexible shoe was put on one foot and a stiff one was fitted at the same time on the other foot. *Observation*: The feeling of freedom produced immediately by the flexible shoe was preferable to the restriction and support of the stiff one. *Interpretation*: Average normal feet, when in a rested state are served best for a while at least by flexible shoes. *Query*: Are flexible shoes then to be considered always preferable to stiff ones? No!

Experiment 2. A pair of very flexible shoes were put on in the morning and were worn throughout the day. *Observation*: They felt delightfully easy at first and continued to be comfortable, although by night there was a slight degree of fatigue noticeable.

Experiment 3. A pair of stiff shoes were put on in the morning and were worn throughout the day. *Observation*: They felt comfortable as soon as they were put on. They were not quite as comfortable at first as extremely flexible ones would have been, but they were plenty comfortable enough, and they continued to feel satisfactory throughout the day. In the evening there was not quite as much fatigue as with very flexible shoes. *Comment:* It should be recalled that this result occurred with average normally functioning feet.

Experiment 4. A pair of shoes having medium shanks which were both semi-flexible and semi-stiff, were put on and were worn throughout the day. *Observation*: They were nearly uniformly comfortable all of the time, and the experimenter was less aware of the existence of his feet than usual when this neutral type of shoe was being worn. Feet were fatigued less at night after this experiment than by either of the more flexible or the stiffer shoes. Feelings of freedom at the beginning of the day, however, were not as pronounced as with more flexible shanks. *Comment*: Does this mean that medium shanks are superior to flexible or stiff ones? It means that medium shanks were superior for a day's time for the experimenter's feet for the particular condition they chanced to be in when the experiment was tried. At some other time somewhat more flexible or less flexible shanks might fulfill individual needs most perfectly for a day. It should be remembered that unusual strains and exertions for the feet may be desirable at intervals for continued maintenance of their strength.

Experiment 5. Flexible shoes were worn during the larger part of the day and stiff ones were substituted at the end of the day. *Observation*: When stiff ones were put on they did not feel quite as comfortable for the first few minutes as when stiff shoes were put on first in the morning. *Interpretation*: Feet had sagged an imperceptible degree in flexible shoes and in consequence bore more heavily on stiff shanks when the latter were used. Stiff shanks restored the imperceptible sagging sufficiently in a few minutes to cause the noticeable pressure to subside. Muscles quickly readjusted themselves to new conditions satisfactorily.

Experiment 6. Stiff shoes were worn during the larger part of the day, and flexible ones were substituted at the day's end. *Observation:* Increased freedom at this time did not cause the same feelings of ease when feet were a little fatigued, as when flexible shoes were put on rested feet in the morning. *Comment:* If sufficient fatigue of foot muscles existed at the time the change was made, presumably then freedom would be less preferable than foot support.

Experiment 7. With a flexible shoe on one foot and a stiff one on the opposite foot, a long, continuous walk was planned in order to tire the feet to a very decided degree. *Comment:* It was thought that first advantages which are possessed by flexible shoes would lessen gradually from the beginning until at some intermediate stage both types might seem quite similar in comfort as far as it could be gauged, and until finally at the end of the experiment, superior comfort might rest with the stiff shoe. *Observation:* The stiff shoe made the leg seem a trifle longer than the other leg; because that foot did not sag or spread with each step in the stiff shoe as much as the other foot did in the flexible shoe. The gait was interfered with enough to cause involuntary imperceptible bending of the knee to equalize the two leg lengths. Knee bending gave muscles that regulated knee posture extra tasks to do in ordinary walking, and they began to show signs of fatigue before foot muscles did. The experiment, therefore, was abandoned because of this unexpected complication.

Experiment 8. Shoes with medium shanks were worn daily for a week without changes to other types. *Observation:* They felt comfortable from the first moment until the end of the experiment, and apparently could have been worn longer with the same degree of comfort. *Comment:* Why should the average person bother with stiffer or more flexible types of shanks when medium shanks are so satisfactory? The answer appears in what follows.

Experiment 9. Various flexible, medium, and stiff shanked shoes were alternated rapidly for three weeks along with snugly and loosely fitted ones. Then a pair with medium shanks and of medium looseness were worn daily for a week. Finally different types were changed at less frequent intervals for an additional period of six weeks. *Observation:* During the first three weeks there was noticed a gradual increase in foot sensitiveness. This never amounted to real discomfort, because shoes were changed when seemingly unfavorable tendencies began to develop. The experimenter simply became more and more continually aware that he possessed feet because of increasing sensations from these regions. One week of use of shoes with medium shanks permitted this increasing irritability to subside again. Six weeks of more deliberate changes subsequently were not accompanied by recurrence of irritability but instead, foot freedom and reserve powers appeared to increase. At the end of ten weeks of experimentation all types of shoes could be interchanged with considerably greater ease than in the beginning. Feet had not been made worse, their efficiencies had been increased. *Interpretation*: The various conditions which the experimenter's feet were subjected to resembled more closely than usual those constant changes that unshod, primitive feet endure with such excellent results to their functions. Their adaptability was increased as well as their muscular strength. If rapid changes of footwear had been persevered in at first, there would have supervened presumably a chronic state of abnormal irritation, and feet would have been "ruined."

Experiment 10. Effects of tight, medium, and loose fittings around the ball of the foot were determined. Shoes very loosely fitted at the ball were found to be very comfortable when put on rested feet. Snug fittings at the ball and waist of shoes were comfortable for rested feet too, but looseness was preferable at the beginning. Snug shoes following loose ones afforded an agreeable change. Loose ones that were put on after snug ones had been worn all day also gave a satisfactory change. Too extreme and too rapid changes increased foot irritability. Continuous wear of shoes of medium snugness and looseness permitted subsidence of irritability. *Comment:* There are people who use tight shoes continuously to hold their weakened feet from spreading laterally. On the other hand sensitive "rheumatic" feet cannot be squeezed into tight shoes with comfort at any time.

Experiment 11. Effects of long and short fittings were determined, also effects of different toe shapes of shoes. *Observation:* If shoes are fitted long enough, less importance attaches to minor variations in outlines of shoe tips. See X-Rays for effects of different toes and for effects of long and short fittings. *Comment:* Short fittings possess practically no merits except the very important ones to certain wearers, namely attractively snug and neat appearances. Short shoes are very liable to produce harmful back pressures on toes with development of anterior arch trouble and corns. Figure 26 shows a small callus that began to develop during the trials with different shoes. If the position of this toe is noticed in the X-Ray pictures, also lines of stitching at posterior edges of toe caps, convincing evidence is furnished that stiff caps are corn producers.

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CHAPTER XXII

X-RAY APPEARANCES OF THE FOOT WITHIN DIFFERENT SHOES

Different shoe shapes and sizes produce different effects on feet; and for this reason in the experimenter's collection of shoes various toes were purposely selected, as well as types of variable degrees of snugness and looseness. An average normal foot should be able to endure comfortably for short periods a wide variety of styles and the X-Ray pictures show how the same foot appears in each of the selected shoes.

X-Rays were taken one after another after all shoes had been assembled. They represent the same foot resting in the shoe in the same posture in each instance and without any weight on the foot. Metal shanks are revealed in their exact positions. Attention is called to extra toe space at the end of the great toe and to great toe deflection. Some shoes can be seen to squeeze the smaller toes laterally more than others. Three groups of shadows can be identified. (1) Foot outlines. (2) Very narrow zones representing upper leather and linings of shoes outside of and in close contact with foot outlines. (3) Sole pattern outlines that run outside of all others at shoe tips, and cross the other shadows where soles narrow down into shanks. Upper leather shadows broaden and shade out completely where rounded edges of shoe tips turn upward on to upper surfaces of the tips.

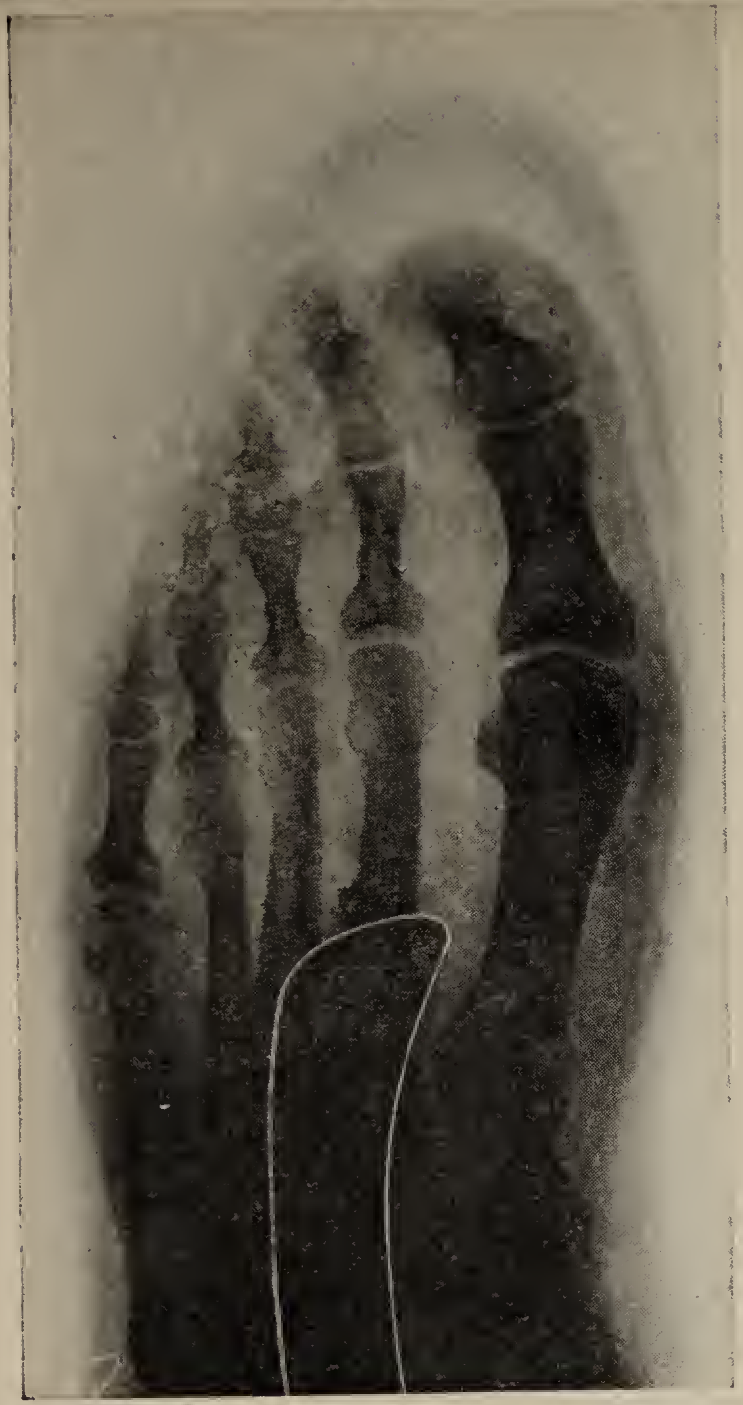

Fig. 19—Anatomik shoe, size 10½ A.

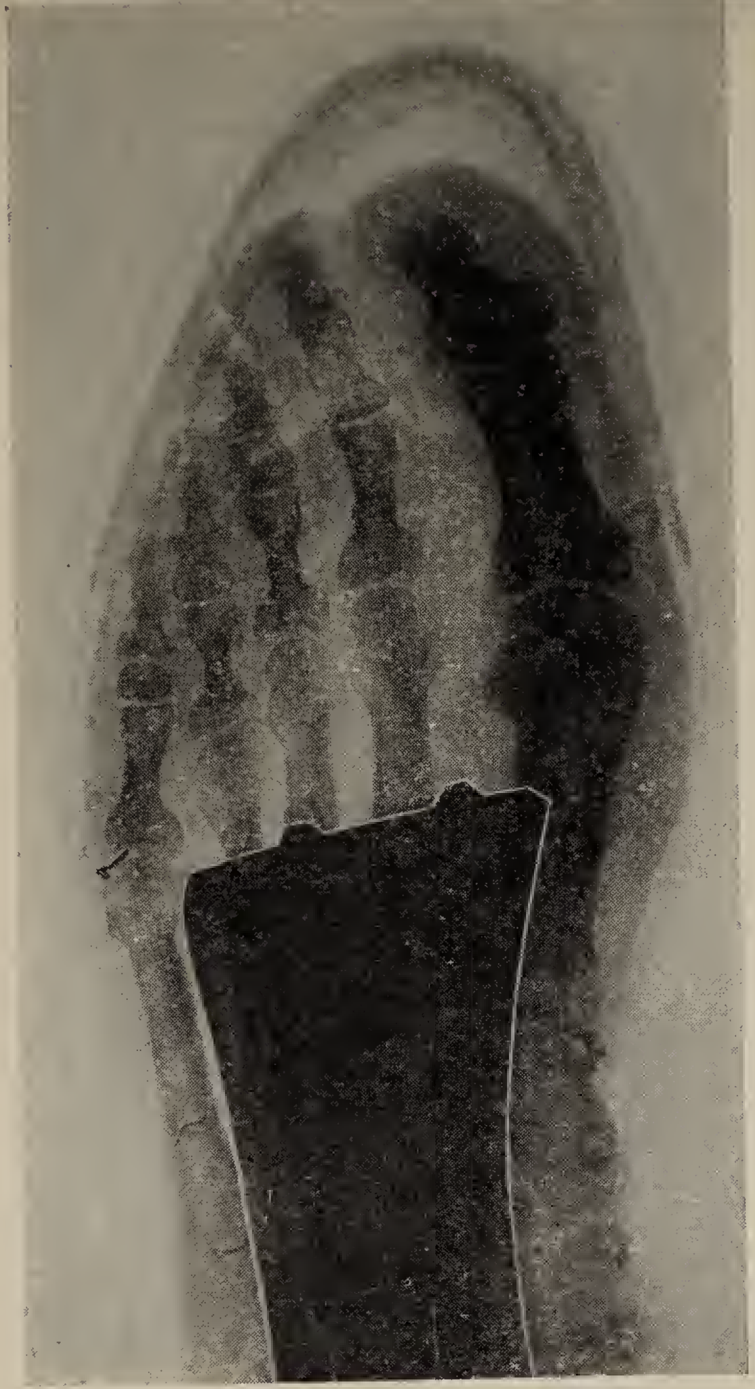

Fig. 20—Arch Preserver shoe, 9½ C. The forward end of the steel shank keeps the sole from sagging at this point and so it supports the anterior transverse arch of the foot more than flexible shanks do.

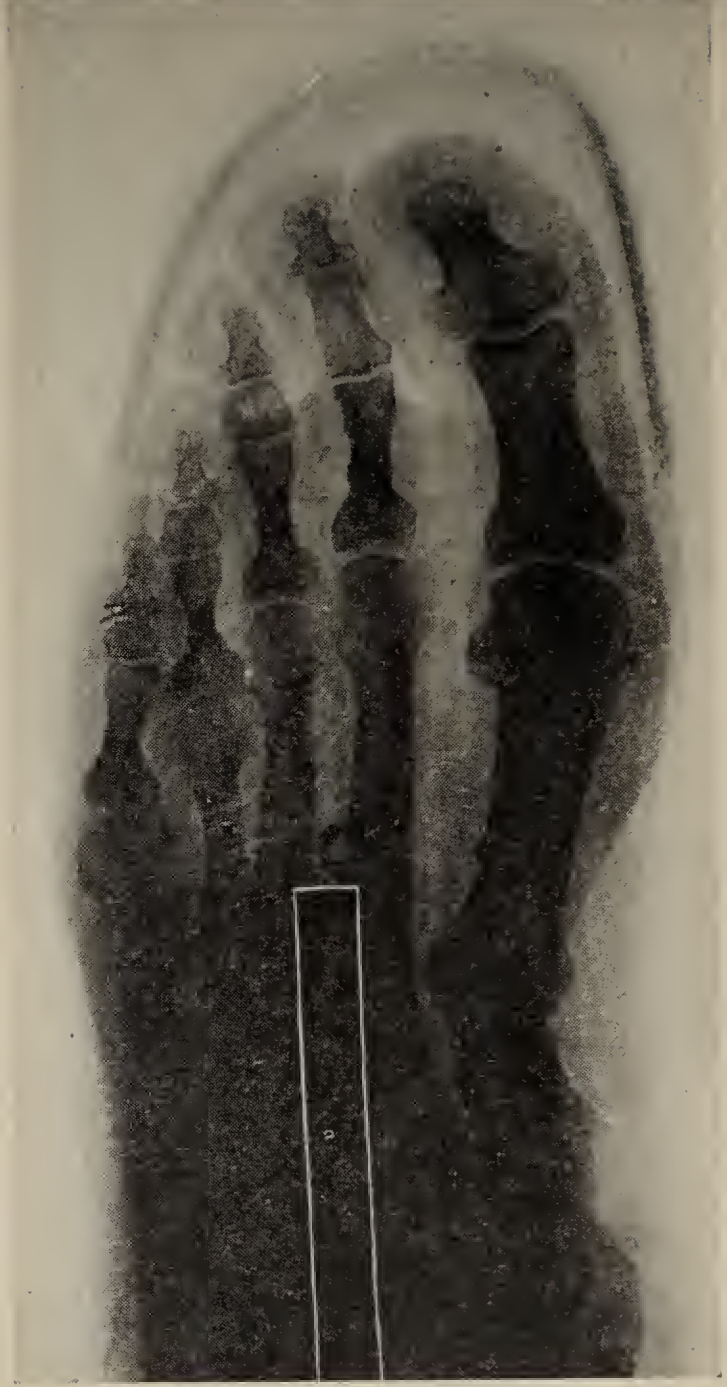

Fig. 21—Educator shoe, size 10½ A, instep size AAA.

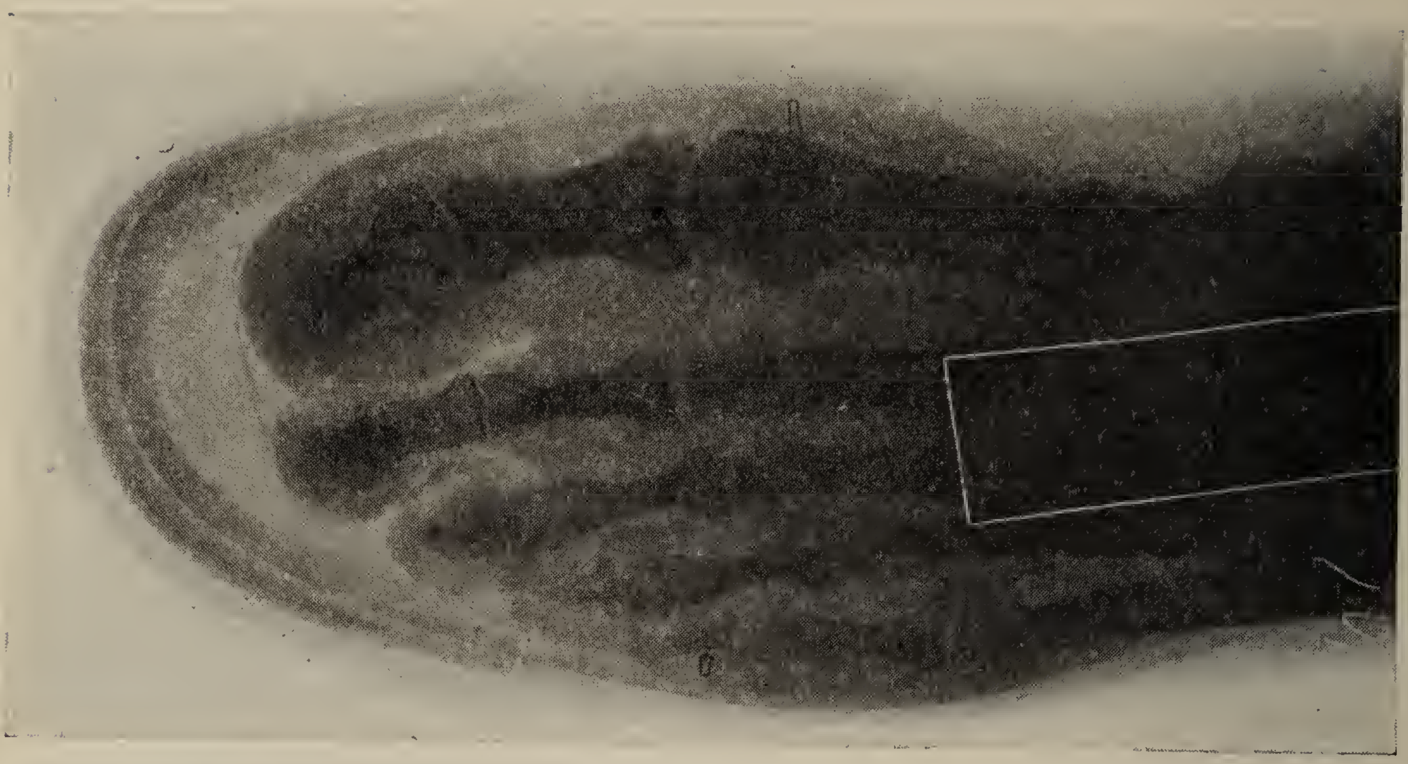

Fig. 22—Hilgert Inner Model, size 10B.

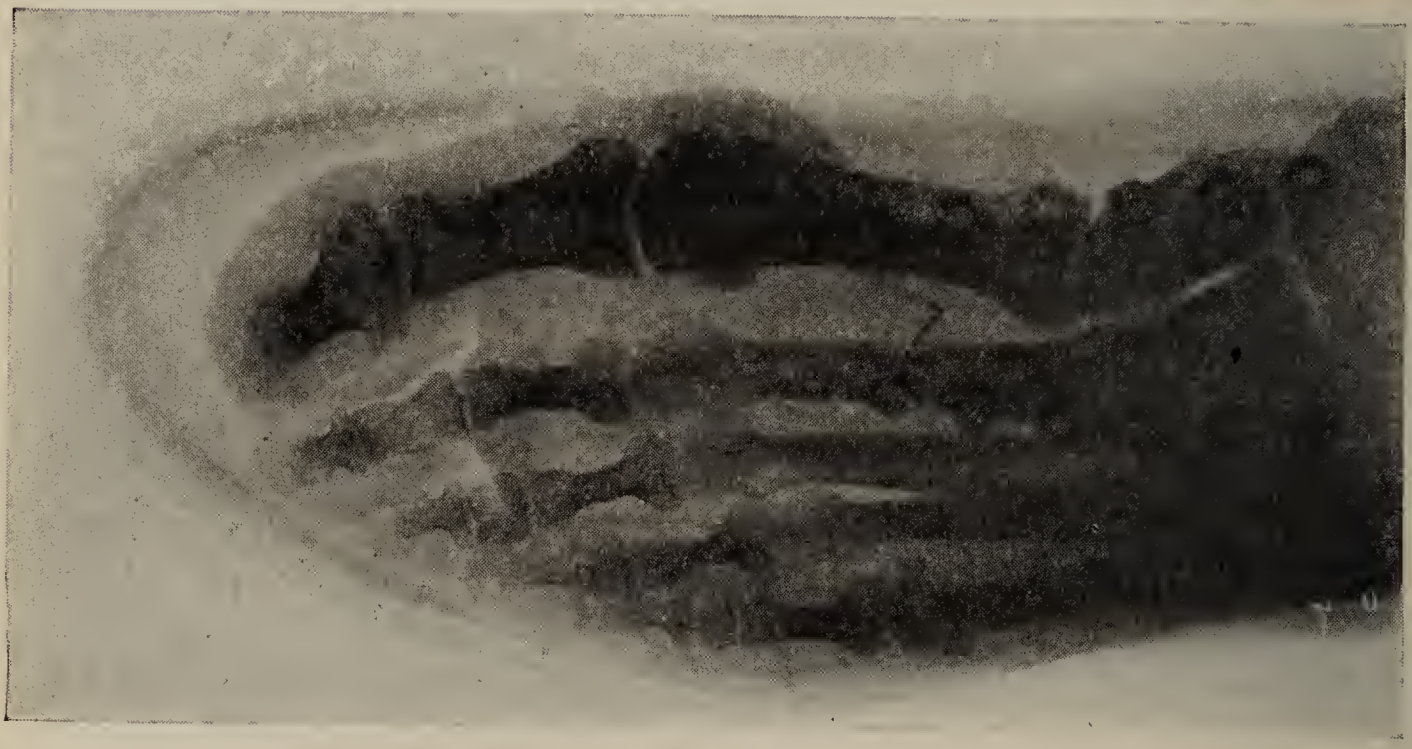

Fig. 23—Everest shoe, size 10 A, instep size AAA. These shoes were as short and snug as could be worn with comfort.

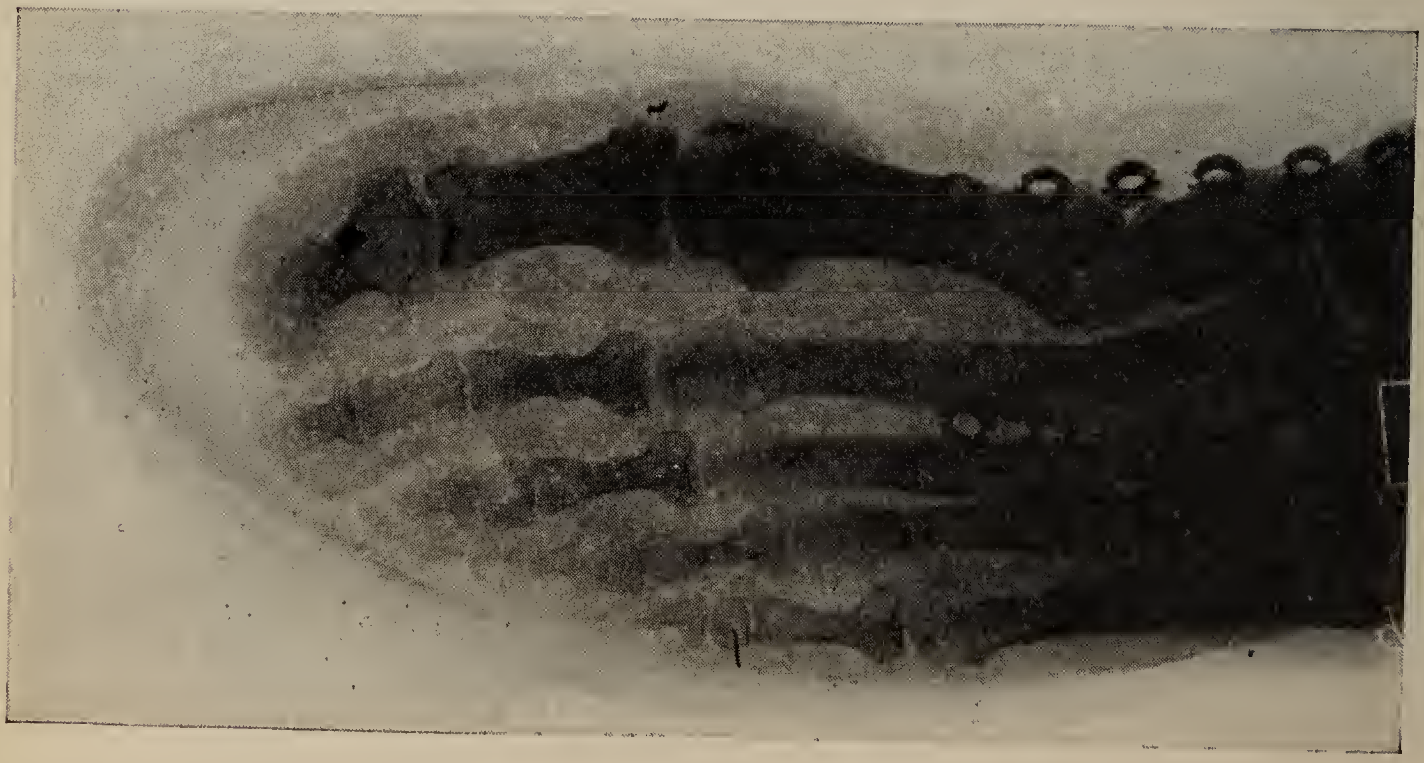

Fig. 24—Supple-Tread Shoe, size 10½ A, instep size AAA.

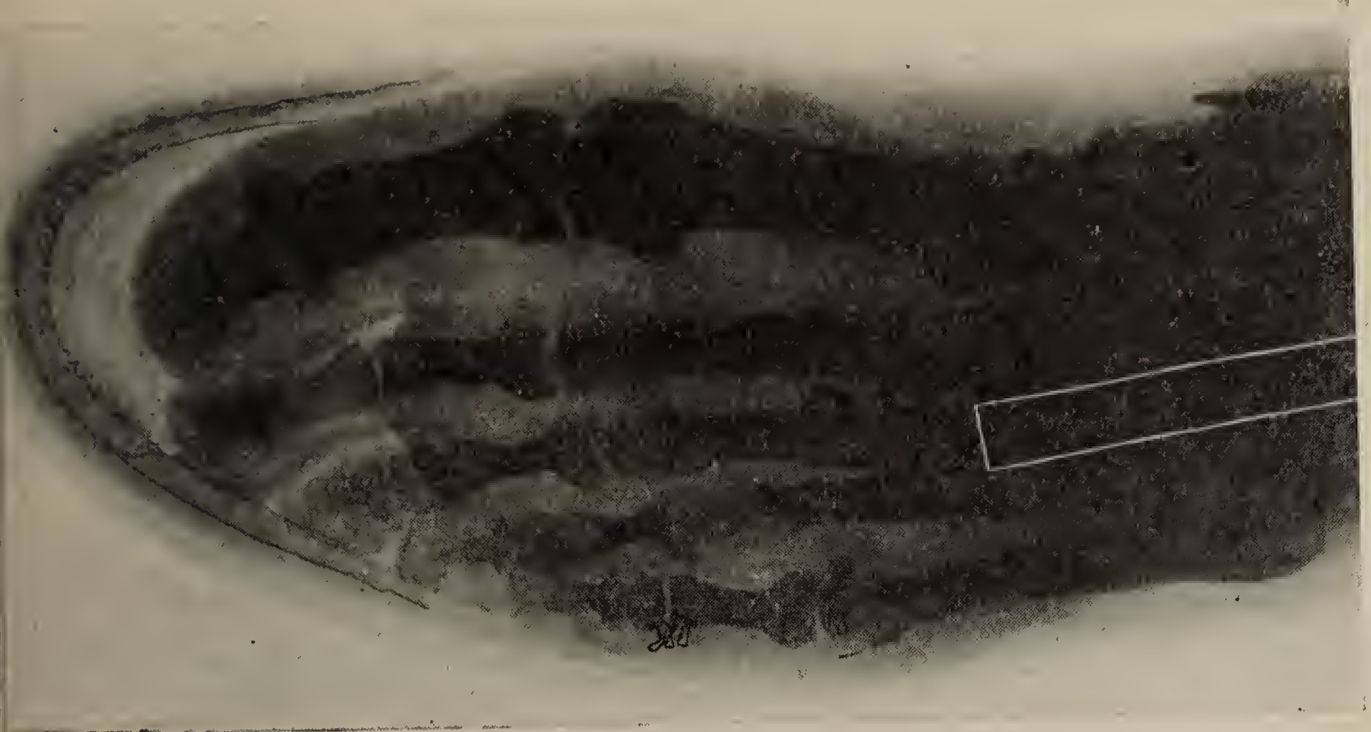

Fig. 25—Glove Grip shoe, size 11 A.

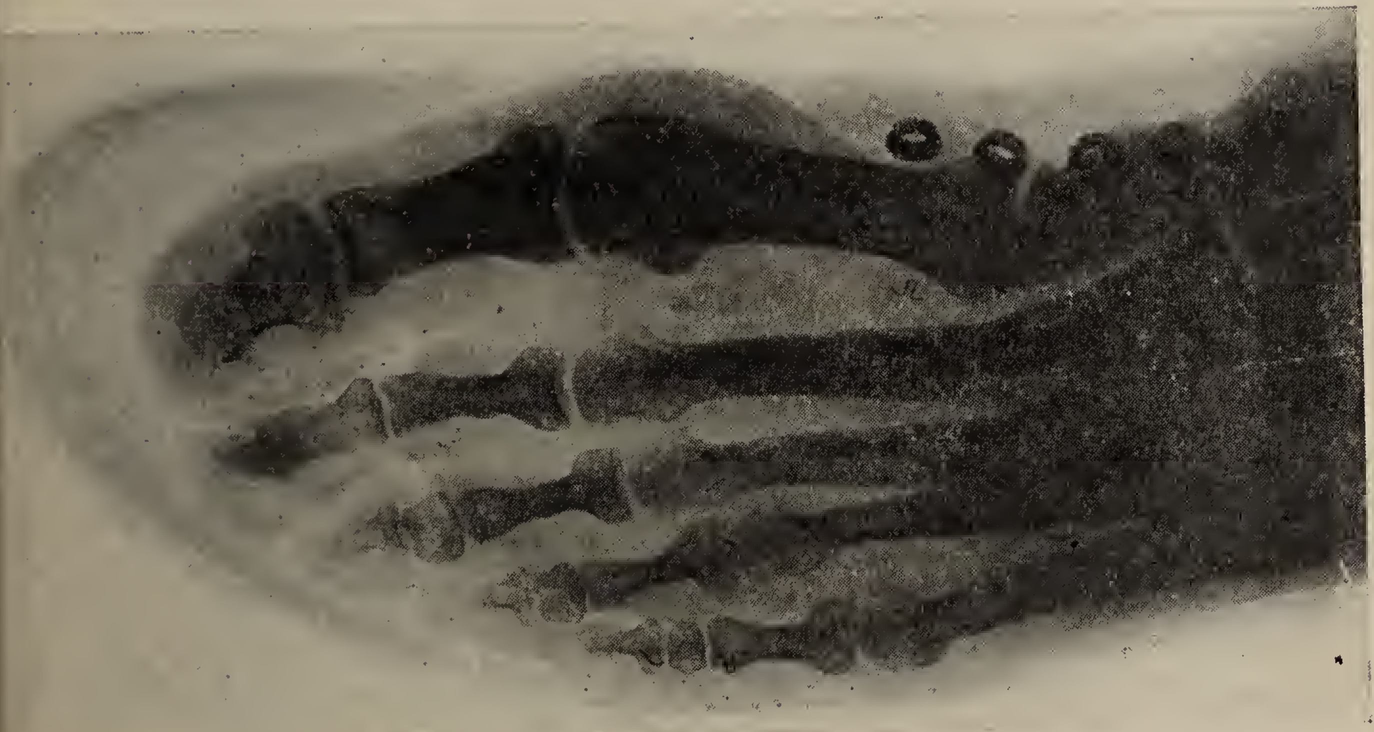

Fig. 26—Ground Gripper shoe, size 10½ A. Space at the inner side of the great toe does not mean that this space is superfluous, for toes may straighten in walking. See photographs of foot without shoes.

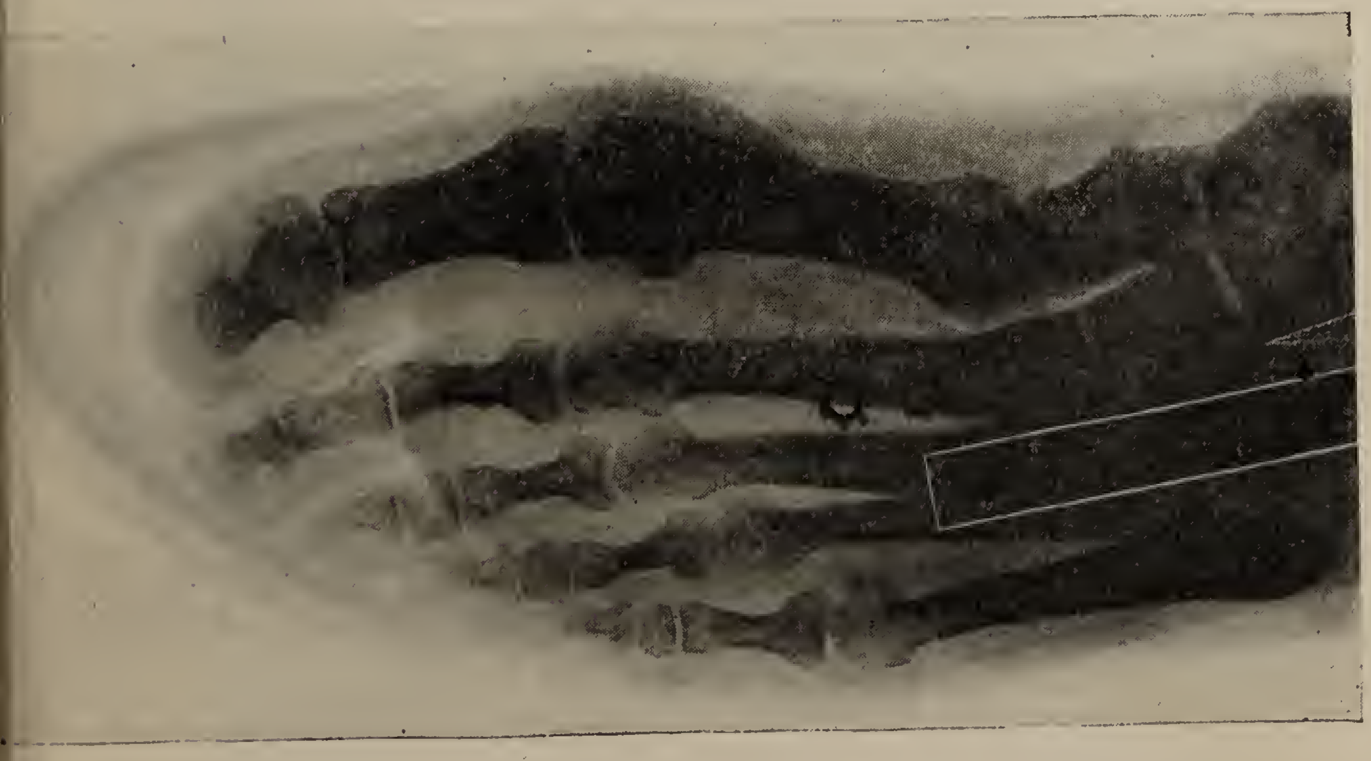

Fig. 27—Trupedic shoe, size 10½ A. Fitted medium loosely on an Outflare last.

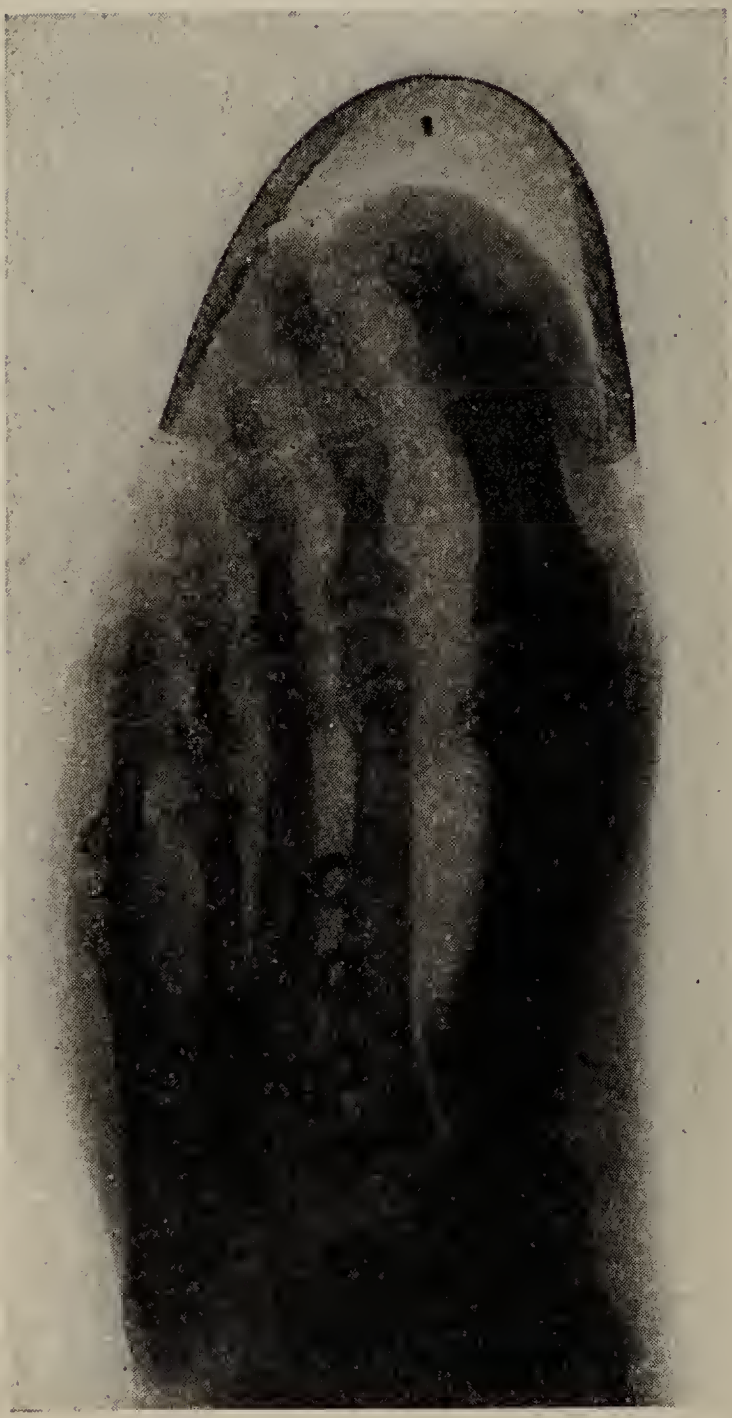

Fig. 28—Sorosis, A. E. Little shoe, size 10 A. Notice how much the toes may be squeezed laterally without discomfort. After very loose shoes the tightness is an agreeable change for a brief period.

Foot Without Shoes. Deflection of the great toe in the X-Ray pictures is a pronounced feature of each; therefore, there is interest in observing the appearance of the foot when it is wholly unrestricted. Compare photographs of the bare foot with X-ray pictures.

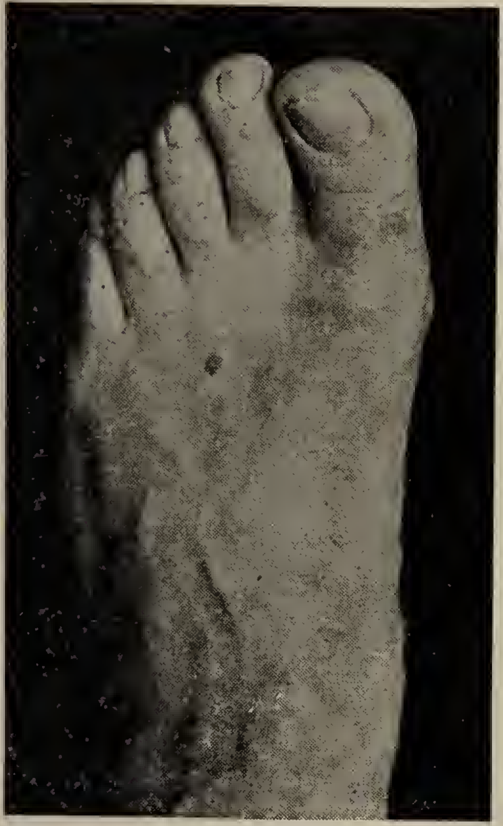

Fig. 29—Foot in same posture as seen in X-Rays and when not bearing weight. The great toe is bent outward and upward in repose.

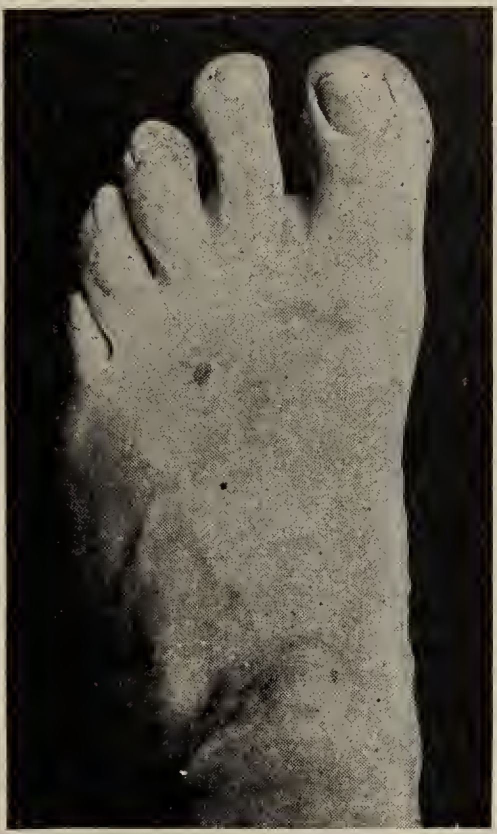

Fig. 30 — Foot bearing weight on its front part. Notice how the toes separate and how the great toe deflection disappears.

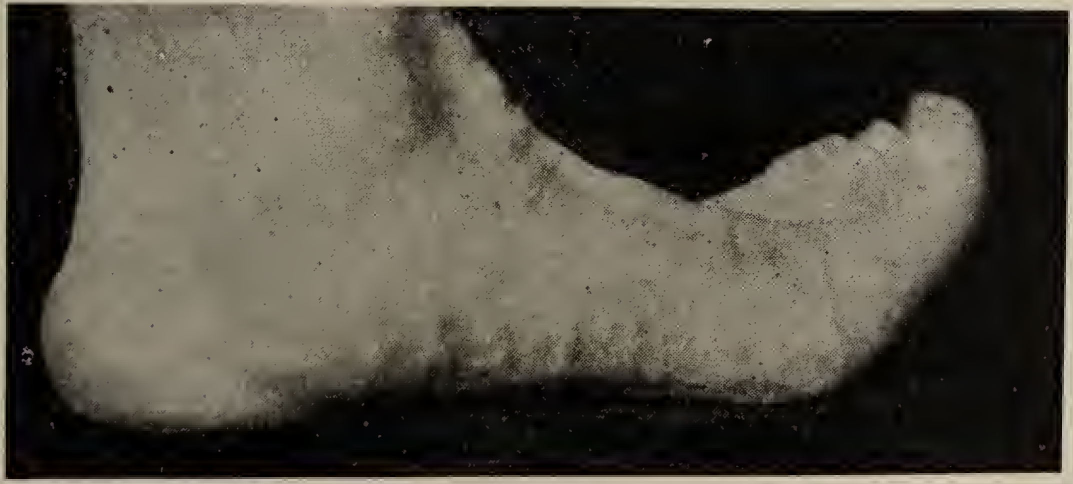

Fig. 31 showing range of upward flexion of toes, also degree of sagging of the instep when weight of body rests mainly on this one foot.

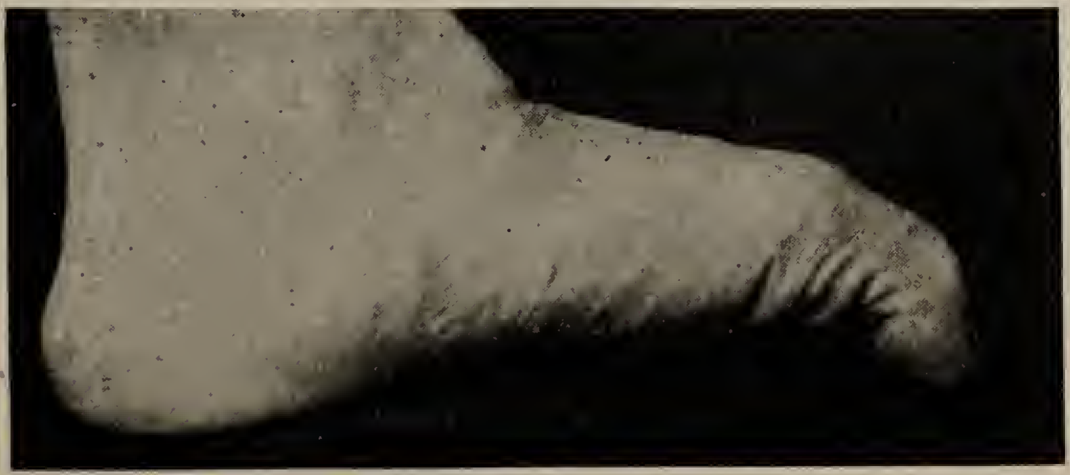

Fig. 32—Downward range of flexion of the toes.

CHAPTER XXIII

VARIOUS CONCLUSIONS AND ADDITIONAL COMMENTS

Flexible Shoes Versus Stiff Shoes. Flexible shoes can be worn by the majority of persons with comfort. Stiff shoes also can be worn by the majority of persons with comfort. Medium shanks have an especially wide range of usefulness, probably even more extended than ranges of usefulness of extremely stiff or of extremely flexible shanks. Feet in flexible shoes at times are harmfully overstrained. Feet in stiff shoes at times are harmfully weakened and irritated. Feet in medium shanks in time may lose their adaptability.

All normal feet begin immediately to adjust themselves to whatever conditions are imposed on them. They will accommodate themselves to increased tasks imposed by the continuous wearing of a single pair of flexible shoes; or they will accommodate themselves to diminished work required by continuous wearing of a single pair of stiff shoes.

Rheumatic foot troubles allow foot comfort only within a narrow range of shoe types. They usually necessitate very careful fittings of medium or stiff-shanked shoes. Small, weak muscles may require the continual use of flexible shoes for maintenance of muscular strength at the level demanded by usual bodily activities.

Feet may break down in stiff, medium, or flexible shoes, if the blood supplying the muscles becomes poor so as to undermine muscular strength.

Flexible or medium shanks are preferable for normal feet if exercise of intermittent light character only is required. Stiff or medium shanks are preferable for normal feet if large amounts of severe exercise must be undertaken continually.

Should One or Several Types of Shoes Be Worn? Each person should possess flexible, medium, and stiff types and wear them all in turn in order to secure most efficient feet. A great many practical shoe fitters say: "Find out the style of shoe that fits your feet and stick to that style exclusively." The writer agrees that this is safe advice and will give very satisfactory results; yet he insists that the preceding statement is true, also, as his own experiments have shown.

Any person with normally functioning feet, who desires to, and is able to keep his feet in best possible condition avoiding development of harmful tendencies, should purchase several pairs of shoes of different types and learn how to use them so that no undesirable tendencies have the chance of becoming firmly established.

Confusion of Shoe Tightness and Shank Flexibility: Very heavy soled shoes sometimes called police shoes, belong to stiff-shanked types. When they are fitted very loosely they should be thought of simply as smooth firm platforms for stockinged feet, and that free play for muscles is permitted nearly as completely as with a bare foot on a smooth, hard floor. Such shoes do not exercise muscles and ligaments as thoroughly however, as thin, flexible soles do when walking is done over irregular ground. Tightly fitted, stiff shoes bind muscles down as to a splint, and snugness of fitting is responsible to an important extent for effects produced, as well as stiffness of shoe shanks.

Smooth even floors and hard, smooth sidewalks, most readers will agree, do not exercise feet as beneficially as do slight irregularities of dirt walks and the natural unevenness of the soil.

Foot Adaptability: Adaptability is accepted without thought. The ability of normal feet to fit themselves to many types of shoes, or to endure remarkable amounts of abuse without trouble, does not cause surprise usually. Surprise and annoyance are elicited over the fact that there are limits to adaptive powers, and as long as feet remain reasonably comfortable in any single type of shoes, wearers seldom appreciate that they may be losing foot adaptive power as a person sitting comfortably in an easy chair continuously loses those powers that are maintained by diversified efforts. Feet may deteriorate from too great comfort enjoyed continuously without change, and a slogan might be suggested "change your shoes often and save your feet." This applies only to normal feet.

Combination Shoe Measurements: They deserve their growing popularity because they are useful for refinements in fitting various foot proportions and shifting needs of feet. There is a negative side to the matter, because heels are sometimes uncomfortably tight, or other individual measurements are too tight. However, such troubles are due to errors of judgment of shoe fitters or of customers usually rather than to defects of shoes.

Cushion Soles and Special Innersoles have a distinct use that is overlooked or minimized frequently by medical men who are interested in foot mechanics principally. Foot postures, maintenance of muscular strength, prevention of deformities, all are very important matters, yet they do not constitute the entire problem of the proper fitting of shoes. Favorable conditions for the normal functioning of skin demands attention very frequently. Cushions or carefully fitted shoes or special innersoles which equalize pressures most perfectly on skin of feet may give comfort that is not supplied by most approved shoe shapes, or other orthopedic features. A very smooth surface against the foot, without any wrinkles or ridges and with cupping of the heel surface, gives comfort that is appreciated sometimes better than support for bones with their controlling muscles when the latter are adequate, if skin happens to be unusually sensitive. Skin is sensitive, or easily calloused, or peculiar in other respects in very many feet, so that for such feet, special innersoles possess decided merits; and it must be remembered that perfect skin comfort may be advantageous for normal feet.

The Retail Store Situation: This deserves mention because there are so many chances in it now for improvements. By looking backward fifteen years, the steady progress that has been made in the understandings of shoe merchants and shoe salesmen can be estimated. A stage has been reached now in which shoe clerks are familiar with many medical notions; but their conceptions still are muddled and inaccurate in a large percentage of all instances.

Systemizations, clarifications, and simplifications as far as possible of medical facts should be attempted; for it is true that harm as well as benefit may result from applications of half truths.

Shoe clerks are in business to sell shoes. They are not their brothers' keepers. But if some of them are possessed also of accurate knowledge concerning the ways normal foot functions are maintained, such salesmen have an advantage over their associates. They will be likely to fit shoes more perfectly, to satisfy customers better, and may represent greater efficiency from a business standpoint. Good feet may be made worse by good special shoes, if the latter are poorly fitted and improperly used.

Some manufacturers and some shoe merchants still claim to be in "straight" business simply; yet in spite of them there is bound to be progress along medical lines until still better understandings of feet by shoe fitters become realities. Advanced useful medical ideas of today are certain of being absorbed by the shoe trade, and will become the commonplace ideas that are familiar to all progressive shoe salesmen of tomorrow.

Scientific truths are not fads like shoe styles, which have a period of popularity and then are replaced by other styles. Rather they are like sound principles of shoe construction which are retained and amplified. So, when there are many excellent special shoes made now, the shoe fitters have their tasks plainly put before them of fitting shoes according to sound scientific principles, accurately, with attention to numerous physiological details; although fashions continue to dominate retail store business. Continued education of shoe fitters and wearers of shoes holds promise to the shoe trade of especially good returns for efforts spent in these directions.

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PART III

A COMPILATION OF CURRENT NOTIONS ON FEET

CHAPTER XXIV

A Survey of Ideas Formulated by Orthopedic Surgeons and Retail Shoe Merchants Based on a Questionnaire Compiled By

Herman W. Marshall, M.D.

A questionnaire of fifty items was prepared by the writer and distributed to orthopedists and retail shoe merchants. One hundred orthopedists from many cities of the United States and Canada replied, and thirty-five non-medical answers were received.

The original fifty statements with additions, comments and criticisms received are given in part below, together with votes of medical and non-medical men on each item.

A few persons returned the set of questions without signatures. Others signed their names but made no criticisms. A few were liberal with comments. Many expressed their approval of the plan and the large majority of replies showed very considerable care in their preparation, so that only two were discarded as being unreliable. The entire set was examined personally by the writer, and very brief discussion of results is undertaken at the end of this paper. An asterisk has been used to identify non-medical comments in tabulations below.

Questionnaire

1—*Shapes of Feet and Usefulness of Feet Vary Independently.*

Orthopedists agreed, 99 = 99 %; disagreed, 1 = 1 %; doubtful, 0 = 0%; no opinion, 0 = 0%.

Shoe dealers agreed, 35 = 100%; disagreed, 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

Duluth, Minnesota—Disagreed.

* * * *

2—*Some Misshapen Feet Are Strong and Serviceable Because Muscles and Ligaments That Hold Foot Bones Together and Move Them Are Usually Strong.*

Orthopedists agreed, 98 = 98%; disagreed, 0 = 0%; doubtful, 2 = 2%; no opinion, 0 = 0%.

Shoe dealers agree, 34 = 97%; disagreed, 0 = 0%; doubtful, 1 = 3%; no opinion, 0 = 0%.

> *Boston, Mass.*—The reason given why some misshapen feet are strong and serviceable is doubtful.
>
> *Boston, Mass.*—Dr. A. G. Howard—Not the only reason.

* * * *

3—*Some Well Formed Feet Are Weak and Unserviceable Because Muscles and Ligaments Are Beginning to Weaken From Some Cause, or Because Disease of Bones or Joints of the Feet Exists.*

Orthopedists agreed, 98 = 98%; disagreed, 0 = 0%; doubtful, 2 = 2%; no opinion, 0 = 0%.

Shoe dealers agreed, 35 = 100%; disagreed, 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

> *Pittsburgh, Pa.*—Dr. E. W. Fiske—They will not remain well formed if weak.
>
> *Shreveport, La.*—Dr. L. C. Spencer—Doubtful.

4—*Majority of Feet Are Sufficiently Well Formed and Serviceable to do the Work Required of Them, Yet There Is a Wide Range Between Maximum and Minimum Degrees of Usefulness Exhibited by Such Feet Among Different Persons.*

Orthopedists agreed, 98 = 98%; disagreed, 0 = 0%: doubtful, 2 = 2%; no opinion, 0 = 0%.

Shoe dealers agreed, 33 = 94%; disagreed, 2 = 6%; doubtful, 0 = 0%; no opinion, 0 = 0%.

> *Los Angeles, Cal.*—Dr. C. L. Lowman. This seems to be too inclusive, and it has been my experience that 50 per cent of all people have some faulty foot statics. Your use of the word "serviceable" would lead one to think that one cannot have symptoms due to feet unless there were symptoms in the feet. Many feet of the type I mention are perfectly serviceable as far as feet are concerned, but the use of them represents many times a very serious nerve loss because of faulty balance. In other words, many remote symptoms are traceable to feet that are apparently symptomless in themselves.

* * * *

5—*Heights of Arches Do Not Measure the Strength or Usefulness of Feet Accurately. Numerous Symptomless Strong Flat Feet Are*

Observed, As Well As Weak Contracted Feet With Unusually High Arches.

Orthopedists agreed, 100 = 100%; disagreed, 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

Shoe dealers agreed, 34 = 97%; disagreed, 1 = 3%; doubtful, 0 = 0%; no opinion, 0 = 0%.

San Antonio, Tex.—Dr. E. A. Cayo—Flat feet may be symptomless, providing the arch is not depressed to the point of supporting contact. One of the chief causes of flat foot is the natural defect of improper alignment of the leg and foot, with the result that both muscle action and gravity act to evert and depress the foot. Another cause is lack of development of foot muscles, this being due to the wearing of shoes (any shape, continuously) during the formative period of the feet.

San Francisco, Cal.—Dr. C. H. Smith—There are numerous strong feet, flat as to imprint of sole, but not abducted on head of astragalus. These feet do not show an atrophied posterior tibial muscle nor a buckled arch.

**Boston, Mass.*—The second sentence is the exception rather than the rule.

* * * *

6—*Flat Foot Signifies That Ligaments and Muscles Have Stretched at Some Time in the Remote or Immediate Past. There May, or May Not, Have Been Subsequent Restoration of Muscular and Ligamentous Strengths, As Existing Strength Cannot be Told From Appearances.*

Orthopedists agreed, 84 = 84%; disagreed, 13 = 13%; doubtful, 3 = 3%; no opinion, 0 = 0%.

Shoe dealers agreed, 31 = 88%; disagreed, 3 = 9%; doubtful, 1 = 3%; no opinion, 0 = 0%.

Hartford, Conn.—A certain amount of flat foot may be perfectly normal to a race, family or individual.

Worcester, Mass.—I assume that "remote" may be interpreted as congenital.

New York City—Many flat feet are congenital, especially among Negroes.

Brooklyn, N. Y.—Long Island Hospital—Agreed with first sentence, disagreed with second sentence.

Denver, Col.—Dr. C. M. Spicer—Disagreed.

San Francisco, Cal.—Disagreed that ligaments stretch. Ligaments are composed of white fibrous tissue and cannot stretch. They pull out an exostosis which simulates stretching.

* * * *

7—*Causes of Muscular or of Ligamentous Weakness Many Times Are Found in Obscure Defects of Circulating Blood, and at Other Times in Nervous Diseases That Affect Nerves Running to Foot Muscles, Producing Weakness.*

Orthopedists agreed, 86 = 86%; disagreed, 2 = 2%; doubtful, 11 = 11%; no opinion, 1 = 1%.

Shoe dealers agreed, 27 = 77%; disagreed, 0 = 0%; doubtful, 2 = 6%; no opinion, 6 = 17%.

New York City—Causes of weakness should include thrombosis, obliterating endarteritis, metabolic disturbances, scorbutus, rickets, osteomalacia, osteitis deformans.

Kansas City, Mo.—Dr. James R. Elliott—Focal foot infections may be causes of weakness.

**Memphis, Tenn.*—Caradine Shoe Co.—Proper fitting will correct muscular trouble.

New York City—Dr. Leo Mayer—Doubtful whether obscure defects of circulating blood are causes of muscular or of ligamentous weakness.

Toledo, Ohio—Dr. N. J. Saybold—Say "occasionally" rather than "many" times that causes are found in obscure blood defects.

Chicago, Ill.—Occasionally but not commonly.

* * * *

8—*Excessive Mechanical Strain From Overuse or Injury Is a Very Common Exciting Cause of Weakness of Muscles and Ligaments. Slight Strains Acting on Muscles Already Weakened Produce Effects Somewhat Similar to Greater Strains Acting on Stronger Muscles.*

Orthopedists agreed, 100 = 100%; disagreed, 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

Shoe dealers agreed, 35 = 100%; disagreed 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

9—*There Are Long Narrow Feet, and Short Broad Ones, Also Many Minor Variations In Foot Proportions Among Different Individuals. All Variations May Be Considered Normal In Many Instances, and Due to Natural Variations In Development of Bones.*

Orthopedists agreed, 99 = 99%; disagreed, 0 = 0%; doubtful, 7 = 1%; no opinion, 0 = 0%.

Shoe dealers agreed, 33 = 94%; disagreed, 1 = 3%; doubtful, 1 = 1%; no opinion, 0 = 0%.

* * * *

10—*Feet Possessing Average Bony Development and Similar Shape May Have Different Degrees of Efficiency However, Because of Differences In Muscles and Ligaments Controlling Them. Too Much Stress Therefore Should Not Be Laid On Ideal Foot Form or Foot Posture. Bony Development Does Influence Foot Efficiency, but In Ways That Are Difficult to Estimate.*

Orthopedists agreed, 94 = 94%; disagreed, 4= 4%; doubtful, 2 = 2%; no opinion, 0 = 0%.

Shoe dealers agreed, 31 = 88%; disagreed, 0 = 0%; doubtful, 2 = 6%; no opinion, 2 = 6%.

> *Cincinnati, Ohio*—Dr. R. B. Cofield—It is questionable whether too much stress can be laid on ideal foot form or foot posture.
>
> *New York City*—Disagreed that too much stress can be laid on ideal foot form or posture.
>
> *Hartford, Conn.*—Dr. Robert M. Yergason—In my opinion it is fundamentally necessary to distinguish between the normal foot and the average foot. The average foot is the racial norm, not that of the individual necessarily.

* * * *

11—*Feet Exhibiting Differences of Form and Posture Sometimes May Possess Exactly the Same Degrees of Efficiency As Far As Can Be Detected. This Is Due to Muscles and Ligaments of Differing Strengths Acting on Bones of Differing Development, the Combined Effects of Bones, Muscles and Ligaments Equaling Each Other in Different Persons.*

Orthopedists agreed, 93 = 93%; disagreed, 1 = 1%; doubtful, 5 = 5%; no opinion, 1 = 1%.

Shoe dealers agreed, 30 = 85%; disagreed, 0 = 0%; doubtful, 1 = 3%; no opinion, 4 = 12%.

* * * *

12—*Normal Foot Function Results From Adequate Exercise and Adequate Rest for Bones, Joints, Ligaments, and Foot Muscle. When There are Restrictions Imposed by Shoes There Are Slight Effects Produced Which Are Not Measurable in Many Instances.*

Orthopedists agreed, 95 = 95%; disagreed, 0 = 0%; doubtful, 4 = 4%; no opinion, 1 = 1%.

Shoe dealers agreed, 34 = 97%; disagreed, 0 = 0%; doubtful, 1 = 3%; no opinion, 0 = 0%.

> **Memphis, Tenn.*—These slight defects may result seriously if not detected.

* * * *

13—*Prolonged Disuse Causes Muscles and Ligaments to Weaken and Shrink Slowly. Excessive Use Causes Them to Become Irritated, Strained and Weakened. An Alternation of Exercise and Rest Is Essential for Maintenance of Average Strength.*

Orthopedists agreed, 98 = 98%; disagreed, 0 = 0%; doubtful, 2 = 2%; no opinion, 0 = 0%.

Shoe dealers agreed, 33 = 94%; disagreed, 0 = 0%; doubtful, 1 = 3%; no opinion, 1 = 3%.

* * * *

14—*Greatest Foot Strength Depends on Maintenance of Best Proportions of Alternating Exercise and Rest in Muscles and Ligaments Originally Well Developed at Birth, and on Continued Excellent Quality of Circulating Blood.*

Orthopedists agreed, 96 = 96%; disagreed, 0 = 0%; doubtful, 4 = 4%; no opinion, 0 = 0%.

Shoe dealers agreed, 31 = 88%; disagreed, 1 = 3%; doubtful, 1 = 3%; no opinion, 2 = 6%.

> *Columbus, Ohio*—Add at end of sentence "and good sensible shoes."
>
> *Toledo, Ohio*—It is doubtful whether greatest foot strength depends on continued excellent quality of circulating blood.

* * * *

15—*Feet Are Adaptable. They Will Accommodate Themselves Without Appreciable Harm for Short Periods of Time to Ill Fitting, Poorly Shaped Shoes of Various Sort, or to Complete Immobilization in Plaster of Paris Casts, or to Free Barefooted States.*

Orthopedists agreed, 97 = 97%; disagreed, 1 = 1%; doubtful, 2 = 2%; no opinion, 0 = 0%.

Shoe dealers agreed, 28 = 79%; disagreed, 4 = 12%; doubtful, 2 = 6%; no opinion, 1 = 3%.

> *Columbus, Ohio*—Ohio State University—Dr. Wingert—They will not accommodate themselves without considerable discomfort.

Baltimore, Md.—Dr. Sydney M. Cone—Agreed if emphasis is laid on "short" periods.

**Rawlins, Wyo.*—E. Mosher—I do not believe that any foot can be put into an ill-fitting or poorly shaped shoe, and the shoe worn more than a day or two at a time without injury to the foot.

**Rochester, N. Y.*—Some feet will adapt themselves, not all.

**West Chester, Pa.*—C. O. Hoffman—Doubtful.

**Memphis, Tenn.*—Shoes that are too short will cause joint trouble very quickly.

**Boston, Mass.*—They will accommodate themselves without appreciable harm for short periods only, but harm is gradually resulting.

15—*New York City*—Dr. V. P. Gibney—Agreed.

* * * *

16—*If a Single Foot Posture Is Maintained Continuously Without Change for a Very Long Period, Then Feet Will Adapt Themselves Slowly to This Position Until It Tends to Become the Natural Comfortable Posture of Repose.*

Orthopedists agreed, 76 = 76%; disagreed, 7 = 7%; doubtful, 16 = 16%; no opinion, 1 = 1%.

Shoe dealers agreed, 26 = 74%; disagreed, 5 = 14%; doubtful, 3 = 9%; no opinion, 1 = 3%.

Boston, Mass.—If you mean that bad static posture of the feet may become a tolerably comfortable one after years, I agree.

New York City—Dr. Henry Keller—Agreed, provided the wearer is very young and the bones are soft and moldable.

Detroit, Mich.—Dr. C. L. Storey—Doubtful, varies with different feet.

Chicago, Ill.—Doubtful, depends on posture assumed.

Des Moines, Iowa—Doubtful as to comfort.

Memphis, Tenn.—Dr. T. H. Ingram—Doubtful.

Boston, Mass.—Dr. R. B. Osgood—Doubtful.

Boston, Mass.—Dr. Chas. F. Painter—Say "feet may adapt themselves" rather than "feet will adapt themselves" then I agree.

Brooklyn, N. Y.—Agreed if the foot posture is a good one, otherwise disagreed.

**Milwaukee, Wis.*—S. J. Brouwer, of S. J. Brouwer Shoe Co.—I presume that a posture of repose would mean a Chinese woman sitting still. For maximum, full, efficient strength we need to restore the feet back to normal.

* * * *

17—*Painless Deformities of Variable Degrees May Develop In This Manner From the Continuous Wear of a Single Size and Shape of Shoes. Bones Slowly Change their Shapes. Some Muscles and Ligaments Stretch While Others Shorten Naturally Until Unequal Pressures and Strains Are Brought Finally Into An Evenly Balanced State of Equilibrium in the Selected Fixed Posture.*

Orthopedists agreed, 82 = 82%; disagreed, 9 = 9%; doubtful, 7 = 7%; no opinion, 2 = 2%.

Shoe dealers agreed, 28 = 79%; disagreed, 4 = 12%; doubtful, 1 = 3%; no opinion, 2 = 6%.

New York City—Dr. T. Halsted Myers—Disagreed.

Chicago, Ill.—Painless for a time.

Los Angeles, Cal.—Disagreed.

**Rochester, N. Y.*—Agreed, generally, yes.

Hartford, Conn.—Ligaments do not stretch but pull the periosteum from the bone, giving pain. The bone then grows into the space under the elevated periosteum. Thus arise deformities of bones which gradually alter their shapes. Ligaments will tear before they will stretch.

* * * *

18—*There Is No Single Ideal Shape or Style of Shoes That Is Best Continuously for All Foot Conditions.*

Orthopedists agreed, 90 = 90%; disagreed, 7 = 7%; doubtful, 1 = 1%; no opinion, 2 = 2%.

Shoe dealers agreed, 31 = 88%; disagreed, 1 = 3%; doubtful, 1 = 3%; no opinion, 2 = 6%.

**Muskegon, Mich.*—Louis P. Haight—I believe that there should be a single shape or style of shoe, and that all shoes which do not agree with this standard shape are incorrect; in other words, there can be but one correct measurement of anything, and that shoes which have been manufactured thus far have been made for style and sale rather than from anatomical lines. There should be a standardization of American shoes.

19—*Many Shapes, Proportions and Sizes of Shoes Are Needed at Times to Fit the Many Shapes, Proportions and Sizes of Feet.*

Orthopedists agreed, 94 = 94%; disagreed, 4 = 4%; doubtful, 0 = 0%; no opinion, 2 = 2%.

Shoe dealers agreed, 32 = 91%; disagreed, 1 = 3%; doubtful, 0 = 0%; no opinion, 2 = 6%.

Sacramento, Cal.—Dr. J. M. Crawford—Disagreed.

Chicago, Ill.—Dr. Schenkelberger—I am inclined to place more blame on poorly shaped and badly fitted shoes than on Nature and lack of proper foot development. Development is hampered by bad shoes even before the child is two years old. Tiny baby shoes are made at least one-quarter of an inch wider at the heel than any normal baby's foot, and there is absolutely no fit in the arch. The tread is either very wide or the shoe fitted too short. Parents should no more think of buying pointed toed shoes for a growing child than they would adopt a square fingered glove for the hand or a three-cornered hat for the head.

Worcester, Mass.—There is a limit that can be reached beyond which the study of shoes possesses but slight merit.

Brooklyn, N. Y.—Dr. Truslow—Suggests a temporary "treatment" shoe for use while temporary apparatus is being worn. It would allow comfort while feet were being padded and strapped, while wearing insole supports with metatarsal pads, and while having convalescent dressings after surgical care. He suggests (a) as its ground plan,—sole shank, heel,—one that is similar to best foot shaped lasts available now with stiff shanks. (b) More front vamp room, i.e., more upper leather from side to side from base of toe forward. (c) Soft vamp with no boxing.

Pittsburgh, Pa.—Dr. E. W. Fiske—States there are two important points which should be put up to the shoe man. (1) The principles of a good shoe, namely, straight line inside or inflare and outflare on prescription from orthopedic surgeon. Good toe room and anterior foot space. Relatively snug heel and instep. (2) Recognition of the pathological foot by shoe fitters. Condemnation of store arch supporters and store doctors. Serious disabilities following lay advice and treatment of flat foot. Realization that a shoe seldom more than aids a pathological foot, that feet should be measured for relief carefully as eyes are, and treated by orthopedists.

* * * *

20—*Shoes Have to Be Adapted to Feet in Some Instances, While Feet Must Be Adapted to Shoes at Other Times.*

Orthopedists agreed, 74 = 74% ; disagreed, 17 = 17% ; doubtful, 6 = 6% ; no opinion, 3 = 3%.

Shoe dealers agreed, 23 = 65% ; disagreed, 6 = 17% ; doubtful, 3 = 9% ; no opinion, 3 = 9%.

Pittsburgh, Pa.—Agreed that poor feet may need to be adapted to good shoes at times.

**Boston, Mass.*—F. W. Small, Gilchrist Co.—Deformed conditions may be slightly bettered by improved shapes of shoes.

New York City—Shoes, like braces, should be applied after correction of deformity in order to retain shape, and not for correction.

New York City—Dr. Armitage Whitman—Disagreed.

Cincinnati, Ohio—Dr. Albert H. Freiberg—Disagreed.

San Antonio, Texas—This is absolutely all wrong.

**Muskegon, Mich.*—If feet are sore they should be corrected before being fitted to any kind of shoes.

* * * *

21—*Shoes Have to Be Adapted Carefully to Feet That Are Very Sore or Weak. Deformed, Symptomless Strong Feet Should Be Adapted Gradually to Improved Shapes of Shoes. Compromises Between These Two Methods Must Be Made Frequently When Complete Lines of Shoes Are Not Available.*

Orthopedists agreed, 91 = 91% ; disagreed, 4 = 4% ; doubtful, 2 = 2% ; no opinion, 3 = 3%.

Shoe dealers agreed, 28 = 79% ; disagreed, 1 = 3% ; doubtful, 2 = 6% ; no opinion, 4 = 11%.

New York City—Disagreed that deformed symptomless strong feet should be adapted to improved shoes.

**St. Johnsbury, Vt.*—Amey & Reed—I question the advisability of changing the shape in a deformed nature shoe, if it is strong.

* * * *

22—*Several Pairs of Shoes of Slightly Different Shapes, Sizes and Balance Are Better to Wear Than a Single Fixed Style Continuously if the Person Is in Good Health and Has Normal Adaptable Feet.*

Orthopedists agreed, 39 = 39%; disagreed, 33 = 33%; doubtful, 26 = 26%; no opinion, 2 = 2%.

Shoe dealers agreed, 15 = 43%; disagreed, 15 = 43%; doubtful, 3 = 8%; no opinion, 2 = 6%.

**Greenberg, Ind.*—Roy C. Kanouse—Wear one style.

**Boston, Mass.*—The shape and proportion best adapted should be generally worn.

**Fort Worth, Tex.*—R. M. Logan, Mosher Bros.—Disagreed.

**Memphis, Tenn.*—Not without pain.

**Rochester, N. Y.*—If the shape and style is right then several pairs of the same kind are all right.

San Antonio, Tex.—Dr. Cayo—This is as free from scientific expression as a frog from feathers.

Louisville, Ky.—Dr. B. S. O'Brien—Disagreed.

Cambridge, Mass.—Dr. W. J. LaMarche—The individual foot has always the same shape. Why change it by prescribing different shapes of shoes?

Washington, D. C.—Dr. C. L. Hall—Agreed.

**Milwaukee, Wis.*—S. J. Brouwer Shoe Co.—Normal, adaptable feet do not last a lifetime if you have shoes that vary in size, shape and balance to any extent at all. If that doctrine were preached to the public, too many folks would get shoes too small.

23—*A Healthy Young Adult Can Wear Without Harm for Very Brief Intervals Almost Any Shoe Shape or Height of Heels, and When This Capacity Begins to Be Lost Then Old Age Is Creeping On, or Muscles and Ligaments Are Weakening from Some Other Cause, or Local Disease Processes Are Developing in Bones or Joints of the Feet.*

Orthopedists agreed, 70 = 70%; disagreed, 16 = 16%; doubtful, 10 = 10%; no opinion, 4 = 4%.

Shoe dealers agreed, 24 = 68%; disagreed, 7 = 20%; doubtful, 1 = 3%; no opinion, 3 = 9%.

**Cincinnati, Ohio*—Potter Shoe Company—Agreed for very brief intervals.

**Rochester, N. Y.*—Agreed if size and fit are all right.

**Memphis, Tenn.*—Continuous abuse will produce premature aging of the feet.

Worcester, Mass.—Dr. F. W. George—I believe this statement is too broad.

Indianapolis, Ind.—Dr. E. B. Mumford—Disagreed.

Kansas City, Mo.—Dr. J. D. Griffith—Doubtful.

Columbus, Ohio—Dr. Wingert—Positively no.

* * * *

24—*Flexible Shanked Shoes Are Best Usually for Strong, Symptomless Feet Because They Permit Most Exercise.*

Orthopedists agreed, 82 = 82%; disagreed, 8 = 8%; doubtful, 8 = 8%; no opinion, 2 = 2%.

Shoe dealers agreed, 26 = 74%; disagreed, 4 = 12%; doubtful, 5 = 14%; no opinion, 0 = 0%.

**Rochester, N. Y.*—Agreed for strong symptomless feet. Flexible shoes otherwise are very harmful and dangerous.

Brooklyn, N. Y.—Agreed unless the individual is very heavy.

Hartford, Conn.—Dr. Ansel G. Cook—I have no objection to flexible soled shoes such as moccasins for normal feet, but when you put a heel, any kind of a heel, on a shoe with a flexible shank you have disturbed the balance and thrown an added pressure on the longitudinal arch of the foot. Some feet are strong enough to bear this added strain, and some are not. Some people with very broad, short feet do not require, in fact cannot, wear a shank. In such cases a broad, low heel gives all the support required. With this exception all shoes that have heels should also have adequate shanks.

Denver, Colo.—Dr. S. Fosdick Jones—Personally, I do not approve of flexible shanks either for deformed or normal feet.

* * * *

25—*Stiff Shanked Shoes Are Best Usually for Delicate Persons Whose Foot Muscles and Ligaments Never Acquire Average Degrees of Strength, or for Those with Disease in the Bones of the Feet.*

Orthopedists agreed, 79 = 79%; disagreed, 9 = 9%; doubtful, 7 = 7%; no opinion, 5 = 5%.

Shoe dealers agreed, 29 = 82%; disagreed, 4 = 12%; doubtful, 2 = 6%; no opinion, 0 = 0%.

**Memphis, Tenn.*—Stiff shanked shoes are especially good for advanced age and increased weight.

**Rochester, N. Y.*—Wm. Pidgeon—Stiff shanked shoes if properly fitted are all right for everyone.

**Muskegon, Mich.*—A stiff shanked shoe which will hold such a foot in position would tend to weaken it rather than strengthen it, and I should prefer strengthening the muscles and putting such a foot into a standard shoe.

Chicago, Ill.—Stiff shanked shoes are best for a time until muscles can be built up.

Atlanta, Ga.—Doubtful whether stiff shanked shoes are best usually for persons with disease in bones of feet.

San Francisco—Dr. Hunkin—I do not think a definite statement can be made in such manner.

Chicago, Ill.—Dr. F. C. Test—Agreed—splints, in other words.

Pasadena, Cal.—Dr. Wm. A. Clark—Doubtful.

**Milwaukee, Wis.*—I would add that stiff shanks are for rest purposes only. Stout people frequently come in this class. I would not put a rigid shank on a delicate person whose foot muscles and ligaments have only average strength, but would use flexible shank shoes in which the uppers act like a bandage.

* * * *

26—*There Are Many Degrees of Flexibility and Stiffness of Shanks, and an Individual Should Wear as Flexible Footwear as His Foot Strength at Any Specified Time Will Permit. He May Wear Stiff Shanked Shoes for Brief Periods with Advantage When Feet Weaken for Brief Periods. He May Wear Flexible Shoes Continuously if His Foot Strength Remains Adequate Continuously.*

Orthopedists agreed, 85 = 85%; disagreed, 11 = 11%; doubtful, 1 = 1%; no opinion, 4 = 4%.

Shoe dealers agreed, 22 = 63%; disagreed, 8 = 23%; doubtful, 5 = 14%; no opinion, 0 = 0%.

**Lincoln, Neb.*—Budd Shoe Co.—Disagreed.

**Dallas, Tex.*—Volk Bros. Co.—Doubtful.

Nashville, Tenn.—Dr. R. W. Billington—The shank of a shoe touches the sole of the foot only along its outer border; and does not support the long arch or prevent pronation or strain on the arch, no matter if the shank is stiff. Support of this arch depends on a broad, long heel built up at front and inner corner. This gives support directly, also indirectly, by preventing pronation. An additional help is a narrow shank well curved or cut under at the inner border. A broad, stiff shank serves as a stiff board to which the foot is strapped and thus flattened as the shoe is laced.

27—*Feet Can Serve as Indicators of Health. In Modern Complex Life There Are Noticed Many Individuals with Recurring Mild, Short Attacks of Foot Strain. Foot Conditions Roughly Fluctuate with States of a Person's Health. The Step Is Elastic, Light, Firm and Brisk in Good Health. It is Less Elastic, Heavier and Slower as Debility Comes on and as Definite Foot Weakness Appears.*

Orthopedists agreed, 92 = 92%; disagreed, 1 = 1%; doubtful, 6 = 6%; no opinion, 1 = 1%.

Shoe dealers agreed, 31 = 88%; disagreed, 2 = 6%; doubtful, 2 = 6%; no opinion, 0 = 0%.

Worcester, Mass.—In many but not all cases of ill health.

**Hutchinson, Kan.*—Some people have bad feet, but are perfectly healthy.

* * * *

28—*Removable Foot Supports for Longitudinal Arches Possess Important Advantages in Being Easily Regulated in Their Use. They Permit Support in Mild Cases of Foot Strain for Brief Periods, and Need Not Be Worn Too Long, as May Happen More Frequently if Stiff Shanked Shoes Alone Are Relied on Without Other Types to Change To.*

Orthopedists agreed, 78 = 78%; disagreed, 12 = 12%; doubtful, 7 = 7%; no opinion, 3 = 3%.

Shoe dealers, agreed, 25 = 72%; disagreed, 5 = 14%; doubtful, 5 = 14%; no opinion, 0 = 0%.

New York City—Agreed theoretically, but most people wear them all of the time or not at all.

Philadelphia, Pa.—Dr. Rugh—I use these supports only for relief of pain which will not yield to balanced shoes.

San Francisco, Cal.—Dr. A. L. Fisher—I believe that all stiff shanks and all plates are to be avoided excepting possibly Whitman plates.

Des Moines, Iowa—Properly fitted shoes and exercises are better.

Oakland, Cal.—Dr. N. Austin Cary—Opinion depends on type and construction of arches used.

Cleveland, Ohio—Dr. Gordon N. Morrill—I do not use plates for any but the anterior arches, and have found much to my relief and to my patients' relief, that teaching them how to stand and to walk is 99 per cent of the game.

**Rochester, N. Y.*—It all depends on what kind of stiff shanks are worn.

**Muskegon, Mich.*—I have found that the cause of longitudinal arch trouble is almost always due to turning out of the feet thereby stretching the muscles.

**Chillicothe, Ohio*—Herman Bros.—At least a dozen representatives are building so-called arch support shoes, and most of them have merit. Supports can be built in several types of lasts, which I think is correct, as it does not compel different styles of feet to conform themselves to the swing last or extreme broad shank. One may be correct in one instance and wrong in another.

Kansas City, Mo.—Dr. Robt. McE. Schauffler—Agreed, with reservations as to the kind of support.

**Milwaukee, Wis.*—I think if a person is selling all sort and shapes and kinds of shoes, and merely wants to "get by," that removable supports will answer but, from my experience, I feel that where shoes are built anatomically correct as far as shape of the curves and contour of the inner sole are concerned, that people ought not to be abused with extra supports shoved into shoes that are incorrect in their alignment.

* * * *

29—*Removable Supports Can Be Inserted in Flexible Shoes, Converting Them Into Stiff Shanked Types Temporarily, and Thus Extending the Limits of Range of Flexibility and Stiffness Obtainable With a Single Pair of Shoes. By Grading Amounts of Support by Numbers of Hours That Supports are Worn Daily, Transitions Can Be Made Gradually and Conveniently From One Type to the Other.*

Orthopedists agreed, 76 = 76%; disagreed, 15 = 15%; doubtful, 5 = 5%; no opinion, 4 = 4%.

Shoe dealers agreed, 19 = 54%; disagreed, 6 = 17%; doubtful, 5 = 14%; no opinion, 5 = 14%.

Philadelphia, Pa.—Dr. Arthur J. Davidson—It can be done but is it advisable?

Iowa City, Iowa—Dr. A. Steindler—No flexible shanks for the uncompensated foot.

San Francisco, Cal.—Dr. G. J. McChesney—I consider arch supports unnecessary. Lessen the load on the arch and strengthen the arch supporting structures. I throw the weight toward the outer side of the foot by built up shoes, correct the posture in walking, and give exercise to strengthen the tibial muscles. When this is not enough, rest in bed and plaster splints are indicated.

San Francisco, Cal.—Absurd to put supports in flexible shoes.

Kansas City, Mo.—Dr. James R. Elliott—I do not use rigid supports.

New York City—These cases should have padded insoles instead of stiff metal plates.

Birmingham, Ala.—Dr. E. L. Scott—Disagreed.

Rochester, N. Y.—Disagreed, the heel and ball will pull apart, and that ruins the foot.

Los Angeles, Cal.—Dr. Lowman—This is misleading in that such a course might lead many patients to keep on wearing an old flexible pair of shoes bought early in the course of treatment, which represent more or less their old faulty condition. I agree that the transition can be made gradually from a stiff to a flexible shoe, but it should be understood that the shoe is of an entirely new type which represents an advance. The gradation should be one of going from arch plates to stiff shank shoes, and later from stiff shank shoes to flexible shoes if desired.

30—*Whitman or "Rocker" Plates Not Only Hold the Feet, but Tend to Restore Sagging Arches to Former Postures. These Supports Are Rather Difficult to Make and to Fit Well, Also They May Be Uncomfortable to Wear if Quick Corrections Are Attempted, Yet They Are Unusually Effective in a Difficult Set of Cases.*

Orthopedists agreed, 72 = 72%; disagreed, 15 = 15%; doubtful, 9 = 9%; no opinion, 4 = 4%.

Shoe dealers agreed, 19 = 54%; disagreed, 4 = 12%; doubtful, 1 = 3%; no opinion, 11 = 31%.

Worcester, Mass.—They have an extremely limited field.

Detroit, Mich.—They do not tend to restore sagging arches without developmental treatment.

Boston, Mass.—Only for young people and children.

Chicago, Ill.—Agreed in very rare cases.

San Francisco—Absolutely torturing and unpardonable.

New York City—Agreed, but many patients prefer to carry their Whitman plates in their pockets instead of putting them into the shoes.

Hartford, Conn.—Once an arch support always an arch support unless muscles can be built up.

Atlanta, Ga.—Dr. F. G. Hodgson—Doubtful.

Syracuse, N. Y.—Syracuse Clinic—Doubtful.

Buffalo, N. Y.—Disagreed.

* * * *

31—*Anterior Arches of the Feet Are Depressed Abnormally Very Often by Continuous Wear of High Heeled Pointed Toed Shoes. When Anterior Arches Weaken, Such Shoes Should Be Discarded Until Feet Have Recovered Thoroughly. Restoration of Anterior Arches Is Accelerated by Temporary Use of Anterior Arch Pads and Appropriate Foot Exercises.*

Orthopedists agreed, 99 = 99%; disagreed, 1 = 1%; doubtful, 0 = 0%; no opinion, 0 = 0%.

Shoe dealers agreed, 30 = 85%; disagreed, 4 = 12%; doubtful, 1 = 3%; no opinion, 0 = 0%.

**Lynn, Mass.*—E. H. Dunbar—Add at end of statement—"and shoes that are of sufficient length to relieve back pressure."

Chicago, Ill.—It may not be safe to discard high heeled shoes suddenly if heel cords are shortened.

**Rochester, N. Y.*—Anterior arches are depressed very often by high heeled pointed shoes that have *flexible shanks.*

**Boston, Mass.*—When anterior arches weaken such shoes should be discarded for all time.

**Boston, Mass.*—Mr. Thomas Burns—The value of physical therapy, massage, and gentle repeated manipulations should be emphasized when attempting to restore anterior arches and toes that have not been crumpled too long. It is possible to assist bones to resume their normal relationships, also to relieve sometimes undue tensions that have tended to develop as toe joints and medio-tarsal joints have been subjected to harmful strain, with tendencies toward gradual subluxations. Contracted toes can be gently and gradually straightened; and tendons that move them may be helped to resume their usual smoothly functioning control. Temporary pads are very important adjuncts to maintain advantages gained between treatments.

32—*Shoes That Possess Inswinging Front Parts of Approved Orthopedic Style May Be Excellent for Longitudinal Arches, and May Be Harmful Simultaneously for Weak Frontal Arches. In Such Shoes There Is Shifting of Weight More to Outer Edges of Feet and Toes. The Same Direct Pressure That Is Exerted Very Commonly on the Outer Toes, Deflecting Them and Producing Calluses, While It Helps to Maintain the Longitudinal Arch Also Thrusts the Frontal Arch Downward. When This Condition Develops, There Should Be Given More Support Under Longitudinal Arches, and Shoes Fitted Which Possess Sole Patterns That Conform More Closely to Imprints of the Bare Feet. New Straighter Lasts Should Be Recommended and Fitted Long, with Frontal Arch Pads Temporarily to Hold Anterior Arches.*

Orthopedists agreed, 74 = 74%; disagreed, 9 = 9%; doubtful, 10 = 10%; no opinion, 7 = 7%.

Shoe dealers agreed, 30 = 85%; disagreed, 3 = 9%; doubtful, 1 = 3%; no opinion, 1 = 3%.

> *Boston, Mass.*—I disapprove entirely of inswinging shoes under any circumstances.
>
> *Philadelphia, Pa.*—There is no piece of leather made that will hold the foot laterally.
>
> *New York City*—Applies only if the shoes are fitted too short or narrow or both, or if there is marked deformity of the foot.
>
> *Chicago*—Doubtful whether new straighter lasts should be recommended.
>
> *Winnipeg, Manitoba*—Disagreed—Galloway-Gibson Clinic.
>
> **Rochester, N. Y.*—Generally correct.
>
> *Worcester, Mass.*—The shoe fitter should not attempt fitting shoe until arch pads are secured.
>
> *Scranton, Pa.*—Dr. E. Sturge—Pads give temporary relief but metal supports are more curative because they are more efficient.

* * * *

33—*Anterior Arches That Are Weakening in Natural Foot Shaped Low Heeled Shoes, Can Be Held by New Shoes More Snugly Fitted at the Waist of the Shoe, or by Independent Anterior Arch Cuffs That Can Be Worn in Loose Shoes. The Latter Method Combines in a Single Pair of Shoes the Possibility of Easily Changeable and Variable Degrees of Support and Freedom.*

Orthopedists agreed, 86 = 86%; disagreed, 3 = 3%; doubtful, 8 = 8%; no opinion, 3 = 3%.

Shoe dealers agreed, 27 = 77%; disagreed, 3 = 9%; doubtful, 3 = 9%; no opinion, 2 = 6%.

New York City—Dr. Irving D. Steinhardt—Disagreed.

New York City—Anterior arch cuffs will have the tendency to weaken further the muscles and ligaments of the anterior part of the foot.

San Francisco—Shoes snugly fitted at the waist of the shoe are chilblain makers.

Providence, R. I.—Dr. Peckham—I never use anterior arches.

Los Angeles, Cal.—Dr. Lowman—I should be doubtful in regard to anterior arch cuffs being worn in loose shoes. They are all right if you mean simply symptomatic treatment, and not in reference to continuous treatment.

* * * *

34—*Sole Patterns of Shoes That Are to Be Worn Most of the Time Should Agree with Imprints of Bare Feet as the Latter Are Made While Sustaining Body Weight.*

Orthopedists agreed, 79 = 79%; disagreed, 11 = 11%; doubtful, 8 = 8%; no opinion, 2 = 2%.

Shoe dealers agreed, 29 = 83%; disagreed, 2 = 6%; doubtful, 2 = 6%; no opinion, 2 = 6%.

Hartford, Conn.—Dr. R. M. Yergason—A swing last for a swing foot but for no other.

Brooklyn, N. Y.—Dr. Walter Truslow—Agreed unless correction of deformity is undertaken, in which case shoes should permit correction.

Nashville, Tenn.—Dr. R. W. Billington—Applies only in case of feet of normal shape and attitude. Otherwise the shoe should be more or less corrective in shape.

Denver, Colo.—Dr. R. G. Packard—Doubtful.

**Muskegon, Mich.*—A sole print of a deformed foot is not necessarily a good pattern for a shoe. Any shoe made to fit a deformed foot must be necessarily incorrect.

* * * *

35—*Sole Patterns of Flexible Shoes Often Exhibit Extreme Inward Curving of Their Anterior Parts, Tending to Over-Correct Longitudinal Arches, and This Is a Benefit in Some Instances.*

Orthopedists agreed, 72 = 72%; disagreed, 19 = 19%; doubtful, 6 = 6%; no opinion, 3 = 3%.

Shoe dealers agreed, 17 = 48%; disagreed, 4 = 11%; doubtful, 8 = 23%; no opinion, 6 = 17%.

Boston, Mass.—I do not believe that the foot follows the shoe.

Portland, Oregon—Dr. Chas. R. McClure—Disagreed.

New Orleans, La.—Dr. Hatch—Doubtful.

Chicago, Ill.—I do not believe that flexible shoes correct arches much by their shape.

Boston, Mass.—Such shoes are good only for a very few inswinging feet.

* * * *

36—*Flexible Shoes Should Be Made Also with Less Extreme Inward Swinging of Front Parts, Because There Are Many Deformed and Very Serviceable Feet That Fit More Perfectly in Straighter Lasts. Many Such Feet Will Never Attain Postures Demanded by the Most Extreme Inflaring Shoe Shapes.*

Orthopedists agreed, 90 = 90%; disagreed, 5 = 5%; doubtful, 1 = 1%; no opinion, 4 = 4%.

Shoe dealers agreed, 28 = 80%; disagreed, 1 = 3%; doubtful, 2 = 6%; no opinion, 4 = 11%.

San Francisco, Cal.—Flexible shoes never should be made with heels on them at all.

**Rochester, N. Y.*—Flexible shoes may be wrong, and it is impossible to do a correct job with wrong shoes.

New Orleans, La.—Dr. H. Theodore Simon—I am much opposed to flexible shanked shoes and also plates on the order of Whitman plates, I have found that shoe alterations, preferably the Ridlon wedge—in conjunction with extra heavy shanks in certain cases—give entire satisfaction.

* * * *

37—*Heels Should Be Low and Broad for Men's Wear and of Similar Shape and Height for Women's Shoes, or Perhaps Even a Trifle Higher for Women's Ordinary Wear. Heel Heights Illustrate an Instance of Foot Adaptability. Heels Have Been Worn so Universally and for so Long that the Primitive Heelless Condition Has Become Less Natural for Most People. Foot Efficiency Theoretically May Have Diminished a Trifle, But It Cannot Be Measured or Appreciated in Low Broad Heels with Broad Bearing Surfaces. For Modern Existence, It Would Be Hard to Disprove That Heels Are Not an Improvement Over Less Desirable Barefooted Postures.*

Orthopedists agreed, 89 = 89%; disagreed, 3 = 3%; doubtful, 6 = 6%; no opinion, 2 = 2%.

Shoe dealers agreed, 31 = 88%; disagreed, 1 = 3%; doubtful, 0 = 0%; no opinion, 3 = 9%.

Chicago, Ill.—Dr. John Ridlon—The height of heel should be determined by the degree of possible dorsal flexion of the foot.

New York City—Dr. Dexter D. Ashley—The idea that heels have been worn so universally and for so long that the primitive heelless condition has become less natural for most people, is, to my mind a far fetched one. The child and early adolescent is still a plantigrade. No evolution is perceptible. Thus at 13 years there is a transmutation, a demand for high heels. The short heel cord is evident only after some years of high heels. Heel heights illustrate an instance of foot adaptability to abnormal position of weight bearing. Primitive man walked on the soft ground. Hard sidewalks and floors and much standing today demanded in the walks of life necessitate a heel.

Did you, "the barefoot boy with cheek of tan," have metatarsalgia? No.

Spokane, Washington—Dr. C. F. Eikenbary—Doubtful.

Lynn, Mass.—Everett H. Dunbar—Heels should be made to harmonize with longitudinal arches. An arch with only one-eighth inch elevation at its highest point may be perfectly normal, and all bones may bear evenly on their articular facets. Not much elevation at the heel should be attempted with this type. Longitudinal arches of other feet may have a different curve with three-quarter inch elevation at their highest points, and higher heels are required in this latter type to give a comfortable poise. The natural curve of the longitudinal arch should be carefully considered in every individual case; and, when the right elevation of heel is discovered there should be no deviation made from this level.

Philadelphia, Pa.—About 15 per cent of men and 30 per cent of women have short heel tendons and must wear higher heels.

Los Angeles, Cal.—Dr. Walter C. S. Koebig—Heels may be too low as well as too high.

38—*Continuous Wear of Very High Heeled, Pointed Toed Shoes That Are Fitted Also Continuously Too Tightly and Too Short,* *Should Be Condemned Very Strongly on Every Possible Occasion. The Majority of Foot Deformities Originate in This Manner Among Young Girls, and Are Continued Among Women Who Choose Fashionable Crippling Styles for Continuous Wear Without Change.*

Orthopedists agreed, 100 = 100%; disagreed, 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

Shoe dealers agreed, 35 = 100%; disagreed, 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

**Des Moines, Iowa*—A. N. Canfield, Elwell-Field Shoe Co.—Ninety per cent of all foot trouble is caused by misfitted shoes, and wrong types of shoes. More foot troubles can be eliminated by proper fitting of right types of shoes than by all other remedies.

**Memphis, Tenn.*—Shoes that are too short will cause trouble regardless of shapes.

* * * *

39—*The Public Should Be Protected Against Most Dangerous Varieties of Shoes as They Are Protected Against Harmful Foods and Drugs, but Manufacturers of Fashionable Shoes Should Not Be Held Responsible for Foolishness of Some Customers Who Wear Them Indiscreetly.*

Orthopedists agreed, 81 = 81%; disagreed, 9 = 9%; doubtful, 7 = 7%; no opinion, 3 = 3%.

Shoe dealers agreed, 29 = 83%; disagreed, 5 = 14%; doubtful, 1 = 3%; no opinion, 0 = 0%.

**Boston, Mass.*—The public should be advised but not forced.

**Boston, Mass.*—H. E. Hagan—Disagreed.

**Memphis, Tenn.*—Disagreed—*Caradine Shoe Co. Common sense is the only cure.

**Austin, Texas*—Disagreed. E. M. Searbrough & Sons.

**Des Moines, Iowa*—The salesman can help to protect the public, and can get their appreciation. A. N. Canfield.

**Wheeling, W. Va.*—Disagreed with first sentence. Agreed with second sentence.

**Iowa City, Iowa*—Agreed—W. H. M. Stewart.

**Denver, Col.*—Disagreed—Robt. H. Johnston.

**Dodge City, Kans.*—Agreed—H. E. Ripple.

**Norfolk, Va.*—Agreed—Marc Gray, Hofheimers Bros. Co.

**Moline, Ill.*—*Agreed*—Leo S. Wynes, Wynes Bros.

**Memphis, Tenn.*—Agreed—Zellner Shoe Co.

Indianapolis, Ind.—Dr. H. R. Allen—If the purpose is to put better shoes on the market then information should be given to the manufacturer pertaining to orthopedic shoe construction, and reasons for such different construction.

**Milwaukee, Wis.*—To what extent are we "our brother's keeper"?

* * * *

40—*A Caution Might Be Stamped on Certain Shoes to Advantage As Follows—"These Shoes Are Recommended Highly for Evening Wear, But They May Injure the Feet If Worn Continuously."*

Orthopedists agreed, 80 = 80%; disagreed, 7 = 7%; doubtful, 7 = 7%; no opinion, 6 = 6%.

Shoe dealers agreed, 21 = 60%; disagreed, 9 = 26%; doubtful, 4 = 11%; no opinion, 2 = 6%.

**New Haven, Conn.*—Sydney Stores—Disagreed.

**Boston, Mass.*—Disagreed.

**Chanute, Kans.*—Disagreed.

**Memphis, Tenn.*—Disagreed. A caution on shoes to "stop, look, and listen" would have equal effect. Style is the Kaiser.

**Atlanta, Ga.*—Disagreed. R. A. Rankin, Foot Expert for Fred S. Stewart Co.

**Lewiston, Me.*—J. J. Curran—Agreed.

**Iowa City, Iowa.*—W. H. Stewart—Doubtful.

Chicago, Ill.—Dr. Chas. A. Parker—It would be foolish.

Philadelphia, Pa.—Instead of saying "these shoes are highly recommended" say "may be worn." There is absolutely nothing but vanity to recommend them.

Los Angeles, Cal.—Dr. Lowman—I entirely disagree that we should give any recommendation whatever to any shoe which is not properly shaped, for evening wear, or any other time. It seems to me too much like side stepping, and taking a position of a flexible conscience, rather than being absolutely definite in our surgical demands.

Boston, Mass.—Manufacturers would disagree to such a plan because it would tend to diminish sales, and manufacturers are in business to make as many shoes as they can.

* * * *

41—*A Definite Arbitrary Standard Might Be Established Profitably, and Shoes That Exceed This Limit Should Be Looked on with Suspicion Unless Their Special Uses Are Clearly Defined. Perhaps*

Some Such Scheme Might Tend to Discourage the Invention of Least Desirable Styles.

Orthopedists agreed, 82 = 82%; disagreed, 5 = 5%; doubtful, 6 = 6%; no opinion, 7 = 7%.

Shoe dealers agreed, 22 = 63%; disagreed, 6 = 17%; doubtful, 4 = 11%; no opinion, 3 = 9%.

Philadelphia, Pa.—Utopic, not practical.

**Rochester, N. Y.*—Caution would be advisable.

* * * *

42—*Shoe Retailers Are Obliged to Cater to the Demands of the Public to a Very Important Degree, Yet They Can Influence Opinions of Thoughtful Customers to an Important Degree If They Wish, and Should Use Means in Their Power to Improve Styles of Shoes Worn.*

Orthopedists agreed, 95 = 95%; disagreed, 2 = 2%; doubtful, 0 = 0%; no opinion, 3 = 3%.

Shoe dealers agreed, 33 = 94%; disagreed, 0 % 0%; doubtful, 1 = 3%; no opinion, 1 = 3%.

**Dayton, Ohio*—I believe that you will receive no co-operation worth while in its extent from shoe dealers, especially those catering to working classes.—The Fred Hageman and Sons Company.

**Portland, Me.*—T. O. Vanamee—The greatest faults I find in the commercial fitting of shoes are, lack of understanding of the fitters, too high heels, short shoes from heel to ball, outflare toes.

**Memphis, Tenn.*—The shoe man cannot act as guardian for all customers. He cannot render the services required of a doctor whose skill goes beyond appearances. However, shoes properly fitted can give relief to many of the foot troubles, and this is sadly disregarded by many who buy as well as those who sell.

Boston, Mass.—Retailers are the chief sinners, not the public.

* * * *

43—*Rigid Feet, Fixed More or Less In Restricted Postures, Are Commonly a Result of Abnormal Adhesions Between Opposed Movable Joint Surfaces In the Feet, or of Adhesions Between Tendons and Smooth Sheaths In Which They Slip Normally, or of Delicate Inelastic Fibers That Form Among Muscles and Their Coverings During Inflammatory Processes.*

Orthopedists agreed, 96 = 96%; disagreed, 0 = 0%; doubtful, 4 = 4%; no opinion, 0 = 0%.

Shoe dealers agreed, 29 = 83%; disagreed, 0 = 0%; doubtful, 2 = 6%; no opinion, 4 = 11%.

* * * *

44—*Underlying causes of Foot Rigidity Therefore Usually Are Inflammatory Processes In the Tissues. Inflammatory Processes, In Turn, Are Commonly Caused by Bacteria or Their Products of Growth Which Gain Entrance to Circulating Blood, and Which Then Exert a Harmful Influence As Bacteria Lodge and Grow In Foot Tissues, or As Their Circulating Products Pass Through Feet and Irritate Them In Passing. Let It Be Explained In a General Way That Bacteria and Their Products Get Into Circulation Often During Acute Contagious Fevers, During Blood Poisoning, or From Some Spot of Chronic Infection Containing Bacteria Somewhere In the Body.*

Orthopedists agreed, 84 = 84%; disagreed, 4 = 4%; doubtful, 10 = 10%; no opinion, 2 = 2%.

Shoe dealers agreed, 19 = 54%; disagreed, 2 = 6%; doubtful, 2 = 6%; no opinion, 12 = 34%.

> *St. Louis, Mo.*—Causes of foot rigidity are often traumatic ones.
>
> *Nashville, Tenn.*—Dr. Billington—I agree except that I believe there is a considerable proportion of cases where stiffness is due to sensitive ligaments caused by strain producing muscle spasm without any infectious element.
>
> *Worcester, Mass.*—Dr. Kendall Emerson—As used, term may refer to active or passive congestion. I should consider this the cause rather than bacterial infection in cases being discussed. Certain bacterial infections cause certain cases of rigidity. Should you argue a universal infective cause for rigid feet?

* * * *

45—*Feet Are Both Weak and Rigid in Some Instances. Shoe Clerks Will Save Their Customers Much Trouble, and Save Good Reputations of Their Chiefs If They Refer Such Persons Promptly to Orthopedic Surgeons.*

Orthopedists agreed, 99 = 99%; disagreed, 0 = 0%; doubtful, 0 = 0%.

Shoe dealers agreed, 31 = 88%; disagreed, 1 = 3%; no opinion, 3 = 9%; doubtful, 0 = 0%.

San Francisco, Cal.—I think people generally seek proper advice.

**Greensburg, Ind.*—Take Dr. Scholl's course and fit them with corrective appliances. Beats the doctors' advice.

**Des Moines, Iowa*—Or study these cases themselves so they will be able to give them best advice.

San Francisco, Cal.—Dr. H. L. Langnecker—Agreed.

**Milwaukee, Wis.*—What can the surgeons do?

46—*Best Shoes Attainable Will Not Relieve These Conditions Satisfactorily Alone. Feet May Have to Be Immobilized During Acute Inflammatory Stages in Most Desirable Postures, or Subjected Later to Various Combinations of Passive Exercises, Active Exercises, Manipulations, Massage, and Physical Therapy to Restore Them.*

Orthopedists agreed, 99 = 99%; disagreed, 1 = 1%; doubtful, 0 = 0%; no opinion, 0 = 0%.

Shoe dealers agreed, 32 = 91%; disagreed, 0 = 0%; doubtful, 1 = 3%; no opinion, 2 = 6%.

**Memphis, Tenn.*—Shoe fitters can only give relief when the foot is restricted by outside pressure.

**Milwaukee, Wis.*—I believe that it would be a good thing if the orthopedic surgeons would demonstrate to the shoe retailer just what these are, in order that he may get his shoe customer interested in having the orthopedic surgeon do these things for him. We certainly have not the time in a busy shoe store to go through all the processes mentioned. We could send far more customers to orthopedic surgeons if they would teach us how to diagnose our customers and talk more intelligently so that they would be willing to go to an orthopedic surgeon.—S. J. Brouwer.

* * * *

47—*Blisters, Corns, Callouses Are Very Common and Troublesome Results of Mechanical Irritation From Improperly Fitted Shoes, or Improper Use of Proper Shoes. Prevention of These Troubles Is the Best Procedure.*

Orthopedists agreed, 99 = 99%; disagreed, 1 = 1%; doubtful, 0 = 0%; no opinion, 0 = 0%.

Shoe dealers agreed, 35 = 100%; disagreed, 0 = 0%; doubtful, 0 = 0%; no opinion, 0 = 0%.

**Des Moines, Iowa*—Dr. W. J. Fenton—Improperly fitting hose play a very important role in causation of these troubles.

Hose often shrink in washing and become too tight.

**Boston, Mass.*—Removal of offending pressure is the best remedy.

San Francisco, Cal.—Tips or caps on shoes are corn cultivators. All tips and boxes should be dispensed with.

* * * *

48—*Bunions, With Accompanying Deflections of Great Toes, Are Results of Improper Shoes and Are Very Common, but deflections of Toes May Result Also From So-Called Rheumatic Diseases, or From Bone Disease of Other Nature.*

Orthopedists agreed, 99 = 99%; disagreed, 0 = 0%; doubtful, 1 = 1%; no opinion, 0 = 0%.

Shoe dealers agreed, 33 = 94%; disagreed, 1 = 3%; doubtful, 0 = 0%; no opinion, 1 = 3%.

San Francisco, Cal.—Dr. Leonard W. Ely—Bunions are the result of hallux valgus, and this is congenital.

San Diego, Cal.—Dr. M. C. Harding—Bunions are rarely due to shoes alone.

**Muskegon, Mich.*—Bunions may be the result of improperly shaped shoes, but more often come from pointed-toed hosiery. For a foot held in a pointed bag can get very little benefit from the most perfectly shaped shoe, as the bag inside the shoe is cramping the toes together. I find that pointed-toed hosiery produces more bunions than rheumatism or other diseases.

* * * *

49—*Bunions Can Be Relieved Many Times By a Change of Shoes. In Bad Chronic Cases Surgical Treatment Is Advisable and Yields Excellent Results.*

Orthopedists agreed, 95 = 95%; disagreed, 1 = 1%; doubtful, 4 = 4%; no opinion, 0 — 0%.

Shoe dealers agreed, 28 = 80%; disagreed, 2 = 6%; doubtful, 3 = 9%; no opinion, 2 — 6%.

**Boston, Mass.*—Bunions can be relieved many times by use of proper shield to relieve pressure and to prevent irritation.

**Hutchinson, Kan.*—Cannot always be relieved by changing shoes.

**Muskegon, Mich.*—I would suggest that surgical treatment for any bunion is unnecessary, as I have yet to find a case which will not respond to the proper kind of exercises, provided the patient is under forty years of age.

Chicago, Ill.—Dr. B. H. Monk—Do not believe a real bunion or real hallux valgus is relieved by shoes. It is possible to relieve a tendency that way, but not a really developed one.

Philadelphia, Pa.—Operation is the only cure for established cases.

* * * *

50—*Diseases of Bones, Fractures of Bones, Paralysis of Muscles, Shortening of Tendons With Marked Contractures and Deformities All Frequently Need Surgical Care.*

Orthopedists agreed, 100 = 100% ; disagreed, 0 = 0% ; doubtful, 0 = 0% ; no opinion, 0 = 0%.

Shoe dealers agreed, 35 = 100% ; disagreed, 0 = 0% ; doubtful, 0 = 0% ; no opinion, 0 = 0%.

New York City—Dr. Henry Keller—Conservative treatment should be given a thorough trial, however, before operative procedures are instituted; as many cases are worse after operation than before.

CHAPTER XXV

DISCUSSION OF QUESTIONNAIRE

These collected ideas require considerable effort to read through carefully. Larger numbers might exceed limits of patience of readers, and, with an overwhelming number, decisions would be reached soon probably that each individual case must be handled in strictly individual manner.

Among the total 5000 points voted on by 100 orthopedists, fifty to each person, there were in all 4413 points of agreement, 272 points of disagreement, and 315 points of doubt or no opinion. These figures represent 88% of agreement, 5% of disagreement, and 7% of doubtful points or points not voted on.

For the 1750 total points among 35 shoe men there were 82% of agreement, 7% of disagreement, and 11% of other indeterminate points.

Matters agreed on often are dismissed quickly from mind, while disagreements are retained most clearly sometimes to disproportionate degrees as the result of controversies. It is of interest therefore to observe how well agreed orthopedists and shoe men may be when it comes to a vote despite many confusing comments.

The familiar story of the group of blind men who examined an elephant can be recalled profitably. Each selected a different part; one examined the trunk, another the tail, a third the elephant's side, and so on. In the discussion that followed, complete disagreement was possible, although each examiner was correct within his limited sphere. The point to be emphasized is that controversies in that instance were wholly unjustified. There were no legitimate grounds for arguments. All data needed to be fitted together and retained.

Disagreements about many orthopedic subjects can be included in this class. Disagreements between shoe men and orthopedists are of such nature to a considerable extent.

Partisan viewpoints constitute a second important source for disagreements. A maker or seller of a special type of shoe dwells especially on *merits* of his particular lines. He may notice shoes of different types for comparisons of *disadvantages* of the latter with advantages of his own special kinds. An orthopedic surgeon may become absorbed in determining the benefits of surgery alone, and he may compare his successes with failures of non-operative methods. Such perfectly legitimate one-sided views abound, but, as they increase in numbers, they become responsible also for apparently never-ending controversies.

Controversies and contradictory ideas menace progress and destroy public confidence. Reconstructive periods are imperative when confusion becomes great. An engineer spends much of his time in calculating his engineering problems. The human mechanism is deserving of even greater calculation; and we should not rush ceaselessly and thoughtless from one new idea to the next one. A period of deliberation, and readjustment, now is becoming an increasing need.

Hope of restoration of order and of obtaining clear, accurate, general conceptions of confusing details concerning feet, lies increasingly in impartial fair comparisons—merits with merits, disadvantages with disadvantages, also in collection of all pertinent facts, and in fitting each into its proper place in the whole picture.

If such labors are not undertaken, then accumulated knowledge may become a hindrance rather than an advantage. Patients may receive increasingly poor treatment at times possibly while numbers of special methods and ideas continue to increase. All important regions of the body, it seems, should be surveyed in the same impartial, comprehensive way if orthopedic surgery is to progress in well-balanced manner.

One way of reasoning is that, because one special type of shoes or one orthopedic method is good, others are bad. Instead, shouldn't there be recognition that all methods or types have some object in their existence, and possess some advantages and some limitations of various sorts? Let it be remembered, too, that even very trivial advantages or disadvantages occupy positions of deciding importance occasionally under exceptional circumstances.

After looking over the scope of foot troubles, the need of renewed study of a few fundamental principles of muscle physiology especially, and of the physiology of other foot structures, becomes apparent. Shoe fitters should realize for sake of their customers and their own ultimate welfare that they are not physicians. Physicians ought to realize that tions. Yet each should learn as much as possible of the other's view- they do not know all details of shoe fitting. Each should keep within their own sphere of activity generally, with perhaps occasional exceppoints for closest co-operation. Most shoe retailers should receive support most strongly of the medical profession, and vice versa.

There is good evidence now for accepting the majority of ideas that have been advanced concerning shoes and feet, with their advantages and limitations. Relief for weakened muscles is possible by means of foot plates, pads, strappings, improved foot postures that are assisted by certain shoes, special supporting heels, and some carefully designed and properly fitted shoes possessing reinforced shanks. The special type of support have to be selected according to individual needs and special limiting circumstances.

Weakening muscles can be relieved at times by hygienic measures that increase nerve tone and reduce vascular defects.

Too much and too continuous support must be avoided. Muscles can be improved by increased functional use, flexible shoes, special exercises, massage, and physical therapeutic means, each individual case responding best to individual care.

Corrections of deformities may be attempted at times by manipulations, exercises, strappings, appliances, casts, surgery, and by shoes themselves. Changes from bad shoes to those that allow contracted feet to expand naturally are important factors in foot corrections many times.

Responsibility for success or failure in treatment should not rest on particular types of shoes or medical measures primarily, but on persons who advise them. The agents or methods will be all right when they are used correctly for their intended purposes. Wearers of shoes themselves very frequently indeed are at fault.

In conclusion, the writer wishes to thank heartily all of those orthopedists and shoe men who have made this survey possible, over one-third of the orthopedists and over one-ninth of all shoe men having responded to the questionnaires that were sent out.

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